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14278

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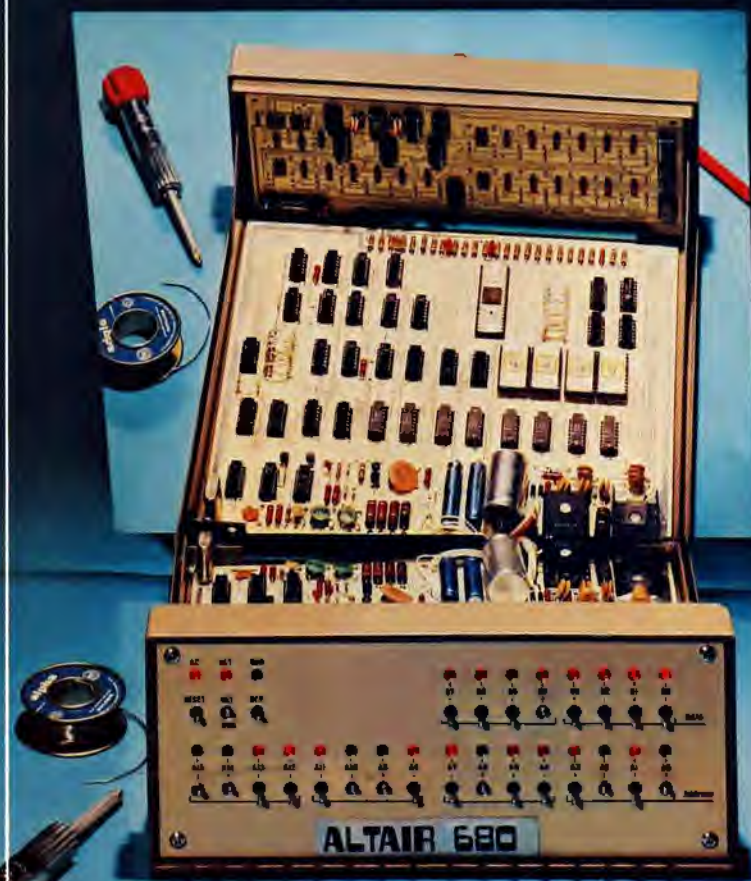
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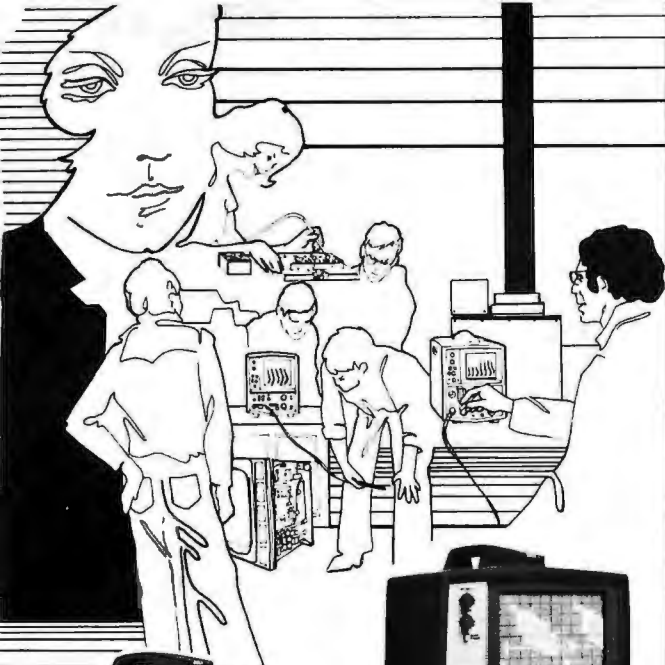
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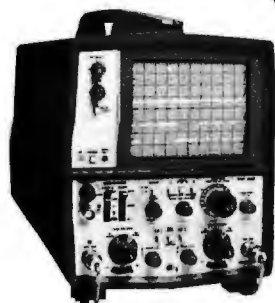


T912

T921



T922



T935



T932



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POPULAR ELECTRONICS, November 1975, Volume 8, Number 5, Published monthly at One Park Avenue, New York, NY 10016. One year subscription rate for U.S., \$6.98; U.S. Possessions and Canada, \$7.98; all other countries, \$8.98. Second Class postage paid at New York, NY and at additional mailing offices. Authorized as second class mail by the Post Office Department, Ottawa, Canada and for payment of postage in cash. Subscription service and Forms 3579; P.O. Box 2774, Boulder, CO 80302.

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Ziff-Davis also publishes Boating, Car and Driver, Cycle, Flying, Modern Bride, Popular Photography, Skiing and Stereo Review.

**Editorial correspondence:** POPULAR ELECTRONICS, 1 Park Ave., New York, NY 10016. Editorial contributions must be accompanied by return postage and will be handled with reasonable care; however, publisher assumes no responsibility for return or safety of manuscripts, art work, or models.

**Forms 3579 and all subscription correspondence:** POPULAR ELECTRONICS, Circulation Dept., P.O. Box 2774, Boulder, CO 80302. Please allow at least eight weeks for change of address. Include your old address, enclosing, if possible, an address label from a recent issue.



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## Editorial

### THE METRICATION WAITING GAME

Although Congress has not as yet passed a bill dealing with adoption of the metric system in the U.S., the changeover from our present English system is inevitable. After all, about 90% of the world's population with 75% of world trade uses the metric system. And with good reason! It's simpler and faster to deal with multiples and subdivisions of 10 than it is with units of 12.

Of course, the U.S. has been "going metric" for many years, although the use of the system has been more of an incursion than an adoption. For example, we employ the metric system for radio wavelengths, electrical measurements, medical prescriptions, and in photography. We even use it for hi-fi pickup tracking force—2 grams, 1 gram, etc.

Comparing the values of one standard with that of another is always awkward. For instance, 1 gram would translate to 1/28 ounce. In a turnabout, 7 1/2 inches per second, a common U.S. tape recorder speed, is equivalent to 19.05 centimeters per second. Clearly, the nice even numbers occur with the standard that is dominant. The equivalent is generally complicated. For international trade purposes, however, many manufacturers "design" metric. That's why you see many cabinets and enclosures that measure fractionally, such as 14 3/16 inches instead of a nice round 14 1/2 inches. The former measures 36 centimeters on the button!

There are many conversion tables around to compare a value in English to that of metric, and vice-versa. Metric conversion calculators are abundant, too. Moreover, there are factors to simplify conversion that are as easy as  $\pi$  to use ( $2.54 \text{ cm} = 1 \text{ in.}$ ;  $1 \text{ kg} = 2.2 \text{ lb.}$ ). But when you get right down to it, one must eventually choose a system to the exclusion of all others so that even numbers predominate. Most countries employed a changeover period from English to metric, with highway signs reading both miles and kilometers, as an example.

The first country to go metric, France, had a 25-year dual system program starting in 1812 before metric became compulsory in 1837. Our defeated U.S. Metrication Bill had a 10-year changeover period.

Interestingly, Thomas Jefferson, when Secretary of State, recommended in 1790 that Congress introduce a decimal system; President John Quincy Adams advocated adoption of the metric system in 1821; Congress passed a law in 1866 making the metric system legal for those wishing to use it. Nearly 110 years later, however, the U.S. is the only major industrial nation in the world that uses the outmoded English system of weights and measures!

For a country that is a major participant in world trade, the delay in converting to metric is abhorrent. It means that a product cannot be made for universal distribution. Equally distressing, there is no serious move in our schools to teach upcoming generations the system of weights and measures that must ultimately be adopted.

*Art Salsberg*



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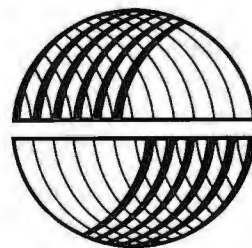
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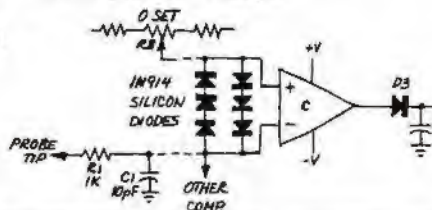
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# Letters

## USING DIODES WITH LOGIC PROBE

In "Build a Universal Logic Probe" (February 1975), it is doubtful that the probe will perform well at frequencies near 10 MHz.

The diodes used to protect the inputs of the comparator IC are the bad guys. The capacitance of a typical zener diode is many times that of a typical switching diode. With the 1000-ohm value of  $R_1$  and approximately 560-pF capacitance of  $D_1$  and  $D_2$ , there will be very little 10-MHz square-wave signal amplitude available at the comparator's inputs.



Far better results can be obtained if the zener diodes are each replaced with two or three switching diodes connected across the comparator's inputs as shown in my schematic.—W.E. PARKER, Columbus, Ohio

## NOTES ON PROGRAMMING PROCEDURE

The 8223 PROM specifications sheet recommends a 390-ohm burn resistor, as opposed to the 39-ohm value specified in "How To Program Read-Only Memories" (July 1975). The exact magnitude difference between the two values makes me suspicious of the article's procedure.—Mark Coffman, Cincinnati, Ohio

I have a question on one of the steps for programming a PROM (page 30). The note in step 1 states: "NEVER operate S1 when S2 is set to BURN." If this is correct, there is no way to blow the fuses.—David Peterson, Edmonton, Alberta, Canada

It has been our experience that most PROM's need a great deal more burn current than is possible to obtain using a 390-ohm resistor. We experimented with a number of PROM's and found that 39 ohms is the optimum burn resistor value. The 390-ohm value failed to give the desired results. (Perhaps the PROM's we had, from several sources, were manufacturer fall-outs; if so, most of the PROM's our readers will be able to obtain are in this category.)

As for the note in step one of the programming procedure, it should read: "NEVER operate S1 when S2 is set to TEST."

## RIPPLE CURRENT IN FILTER CAPACITORS

In "How to Design Your Own Power Supplies" (June 1975), no mention is made of the importance of not exceeding the ripple current rating of the capacitor. This factor cannot be ignored, particularly in low-voltage, high-current power supplies. Failure to consider the ripple current and its heating effect in the capacitor will severely shorten its life.—S.A. Romano, Brooklyn, N.Y.

The author replies that this is a good point to keep in mind if one finds heating in the filter capacitor. The ripple current may be what is causing it. Under normal loads and with full-wave and bridge systems, however, the typical capacitors available to experimenter should not present any problems.

## Out of Tune

In "Build a Direct-Reading Logic Probe" (September 1975), in the Parts List,  $D_{1S}$  should be a common-anode unit, not common-cathode.

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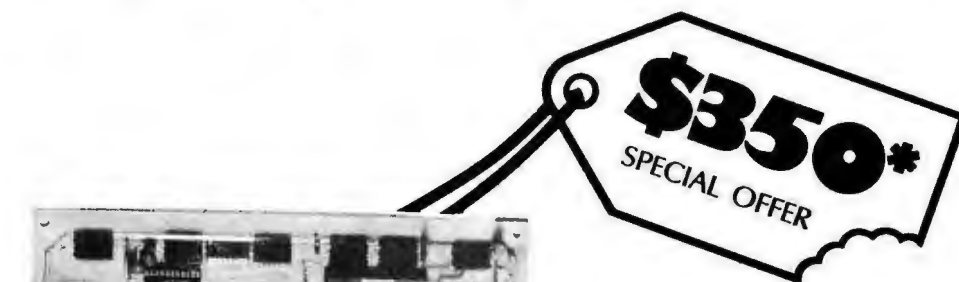


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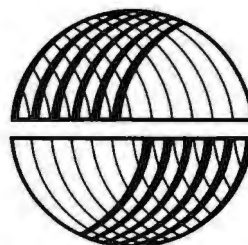
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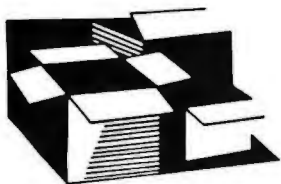
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*Additional information on new products covered in this section is available from the manufacturers. Either circle the item's code number on the Reader Service Card inside the back cover or write to the manufacturer at the address given.*

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The Model RT-824 AM/FM Stereo Tuner by Rotel has a dual-gate MOSFET front end, an IHF sensitivity of 1.6  $\mu$ V, a tuned r-f AM section, and a phase-locked-loop multiplex detector. A wide linear-scale dial and flywheel tuning are included for easy operation. A muting switch selects thresholds of 30 or 50  $\mu$ V, or deactivates the muting



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### B.X. & L. AMPLIFIER DELAY SWITCH

The AMP-LAY-SWITCH™ amplifier delay switch by B.X. & L. Industries is a solid-state switching device that automatically turns off an amplifier at a preset time after an automatic turntable has played its last record. Time delays from 0 seconds to two hours are possible. Since both the amplifier and turntable are plugged into the AMP-LAY-SWITCH, the unit can serve as a master switch for the entire system. A manual/delay switch is included. \$79.95. Address: B. X. & L. Industries, Inc., 17905 Sky Park Blvd., Irvine, CA 92707.

### ADC "NEW MILFORD I" SPEAKER SYSTEM

The New Milford I is part of a series of loudspeakers developed by Audio Dynamics Corp. According to ADC, the speakers have been engineered with emphasis on "uniform energy response," which considers the listening room as an important speaker parameter. ADC claims that such speakers produce a uniformly flat

energy output/frequency bandwidth characteristic, minimizing problems of critical speaker or listener location within the room. The New Milford I is a 3-way acoustic suspension system employing a 10-inch (25.4-cm), long excursion damped woofer which crosses over at 1500 Hz to a 2½-inch (6.4-cm) damped tweeter. Claimed energy response is 45 to 20,000 Hz  $\pm$  3 dB. A contour control adjusts the half-power (3-dB) tweeter rolloff frequency. Minimum recommended amplifier power is 5 W rms. Measures 22½"H  $\times$  13"W  $\times$  11"D (57.2 cm  $\times$  33 cm  $\times$  27.9 cm). Weighs 35 lb (15.9 kg). Simulated walnut grained, non-resonant wood products cabinet. \$99.95.

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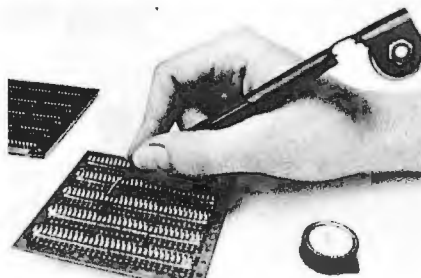
### RCA DUAL-TRACE SCOPE ADAPTER

RCA's new Model WM-541A Dual Trace Adapter converts any triggered or recurrent-sweep oscilloscope to dual-trace operation for servicing audio, digital, and television circuits. The unit can provide additional traces for existing dual-trace scopes. Claimed frequency response is dc to 10 MHz, and display modes are channel A only, channel B only, or both A and B simultaneously (chopped or alternate). Ac and dc coupling are provided for both channels, as well as compensated 6-step (1, 2, 5 ratio) attenuators, separate variable sync-level control with polarity reversing switch, input and output BNC connectors, and vinyl-clad shielded case. COS/MOS integrated circuitry is said to yield a noise level of less than 10 mV, and a maximum signal output of 1 V (p-p). Maximum ac signal input is 50 V (p-p). Input impedance is 1 megohm shunted by 55 pF. The Model WG-400A direct/low capacitance probe is an option. The adapter measures 8¼"  $\times$  5¼"  $\times$  3¼" (21 cm  $\times$  13.3 cm  $\times$  8.3 cm) and weighs 3 lb (1.6 kg). \$108.00. Probe, \$15.00.

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### CIRCUIT-BOARD WIRING KIT

The Solder-Wrap wiring kit, from Applied Manufacturing of Texas, uses a patented wiring wand to dispense heat-strippable wire between components (including IC's) mounted on a special circuit board. Once the wire is routed, connections are heated to remove wire insulation for soldering. This special "hobbyist kit" includes the pencil-shaped wiring wand, a cartridge containing 200 ft. (61 m) of #34 heat-



strippable wire, a circuit board with 15 IC positions and 10 insulating channels, and illustrated instructions. \$11.95. Address: Applied Mfg. of Texas, One Main Place, Box 50273, Dallas, TX 75250.

### CRAIG CB MOBILE TRANSCEIVER

Craig's new Model 4103 mobile transceiver features a quick-release, anti-theft mounting system, crystal synthesizer providing 23 channels, and a 4-watt r-f output. Also



provided are an r-f gain control, delta tune, ceramic filter, voice compression circuitry, adjustable squelch, anl, and short-circuit protection for output transistors. A three-position ANLNB/PA switch, a backlit  $S_{11}$ -1/SWR, and illuminated channel selector facilitate operations. A LED indicates that normal modulation is being achieved. The unit's detachable PTT dynamic mike comes with hanger and hardware. \$199.95.

CIRCLE NO. 89 ON FREE INFORMATION CARD

### TELEX CB HEADSET WITH BOOM MIKE

Operating convenience is afforded by the Model CB 1200 boom mike headset by Telex Communications. Designed for the mobile or base station CB operator, it is a single-sided headset (for either ear) so that contact is not lost with the immediate environment. The dynamic, foam-cushioned earpiece is adjustable for maximum comfort. The boom microphone is also adjustable. A built-in FET amplifier, powered by a 1.4-volt mercury battery, matches the mike to any CB transceiver. An in-line PTT switch is supplied with clothing clip. The switch can be depressed momentarily for short messages or locked-in for longer transmissions. \$59.95.

CIRCLE NO. 90 ON FREE INFORMATION CARD

### HEATHKIT STEREO MIKE MIXER

Heath's new Model TM-1626 stereo mixer is a low-cost console with stereo outputs, four high/low impedance mike inputs (one with pan control), two auxiliary inputs, and slide controls. Switches above each input level control assign that input to the left or right channel or switch it off. A pan control adjusts the apparent location of the fourth mike anywhere between extreme left and extreme right. A mixer bus allows paralleling of any number of TM-1626 units. A pair of lighted VU meters continuously monitor the outputs over two switch-selected ranges—+4 or 10 dB. Peaks are caught by



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# Hewlett-Packard introduces a third scientific programmable:





# the uncompromising HP-25. \$195.00\*

Now you have three HP pocket programmables to choose from:

- the \$795.00\* HP-65 Fully Programmable, with program recording capability;
- the \$335.00\* HP-55 Advanced Scientific Programmable, with 86 preprogrammed functions and digital timer;
- the new, smaller HP-25 Scientific Programmable, with a price that brings programmability within the reach of everyone.

Here's what the new HP-25 offers you:

**Keystroke programmability.** The four-step answer to repetitive problems:

1. Turn the HP-25 on and switch to PRGM;
2. Enter the keystrokes necessary to solve the problem and switch to RUN;
3. Key in a set of variables and press the R/S (Run/Stop) key;
4. Repeat step three for each iteration.

You save time, gain precision and flexibility. You can verify formulas or test alternate approaches without sacrificing half a morning.

**You do it in plain English.** You don't need software or a "computer" language. You don't need prior programming experience.

**Complete programmability.** You can add, check, or change program steps at will. Just use the SST (Single-Step) or BST (Back-Step) key and Display to locate the steps you want to check or change, then enter your changes. The HP-25 displays *all* program steps, so you can *always* tell at a glance where you are in your routine. HP knows you can't edit in the dark.

The HP-25 even has a PAUSE key that lets you write one-second interruptions into your programs, in case you want to pick up intermediate results or verify the progress of a calculation.

In sum, the HP-25 is a complete keystroke programmable calculator, designed by engineers who've done it before. Twice.

**Merged key codes.** Each step in the HP-25's 49-Step Memory can accommodate multi-keystroke functions, because the keycodes of *all* prefixed functions—including the register arithmetic functions—merge. You gain extra capacity, just in case.

**Branching and conditional test capability.** You can program the HP-25 to perform direct branches or conditional tests based on eight different logic comparisons.

**Eight storage registers and 72 preprogrammed functions and operations.** All log and trig functions, the latter in degrees, radians or grads; rectangular-polar and decimal hours-hours/minutes/seconds conversions; mean and standard deviations; summations; register arithmetic on data in *all* registers; an integer/fraction key so you can store two numbers in one register; and all data manipulations.

**Fixed decimal, scientific and engineering notation.**

You know the first two; the third is new to pocket calculators. Engineering notation freezes scientific notation into multiples of  $10^{\pm 3}$ , so you can convert to milli-, micro-, nano-, etc., without counting decimal places on your fingers.

**RPN logic system with 4-register stack.** Here's what this time- and error-saver means for you:

- You can evaluate any expression without copying parentheses, worrying about hierarchies or re-structuring beforehand.
- You can solve all problems your way—the way you first learned in Algebra I, the way you now use when you use a slide rule.
- You solve all problems, no matter how complex, one step at a time. You never work with more than two numbers at once.
- You see *all* intermediate answers *immediately*; the HP-25 executes each function immediately after you press the function key.
- You can backtrack when you err, because the HP-25 performs all operations sequentially.
- You can re-use numbers without re-entering them; the HP-25 becomes your scratch pad.

**HP quality craftsmanship.** One reason Nobel Prize winners, astronauts, conquerors of Everest, America's Cup navigators and over a million other professionals use HP calculators.

**Free Applications Program Handbook.** The price of the HP-25 includes a 125-page handbook that details solutions to a wide variety of problems. HP also offers many accessories designed specifically to help you get more out of the HP-25.

**800-538-7922 (in Calif. 800-662-9862)** are the numbers to call for the name of a dealer near you. He'll give you detailed specs, including a list of available accessories, and a "hands-on" demonstration that'll take about 15 minutes. Buy an HP-25, and you'll get them back. Every day you use it.



Sales and service from 172 offices in 65 countries.  
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# The \$300 alternative.



SAE MARK XVII  
Dual-Channel Equalizer

Your tone controls are just not designed to compensate for

- ☐ Room acoustics
- ☐ Speaker placement
- ☐ Old or bad recordings

We built the Mark XVII Equalizer to solve these problems and more. These are some of the ways:

- ☐ Individual Octave Control for each channel
- ☐ Long throw, oil-damped linear slide pots for greater accuracy
- ☐ Dual range operation (controls operate over either  $\pm 8\text{dB}$  or  $\pm 16\text{dB}$ )

Plus

- ☐ Capable of driving any system
- ☐ Low distortion—less than 0.03% THD and IM
- ☐ Low noise—greater than 90dB
- ☐ 5-year parts and labor service contract
- ☐ SAE's reputation as the finest manufacturer in the audio field

You'd have to look a long time to find an EQ that delivers this much value. SAE innovation has done it.

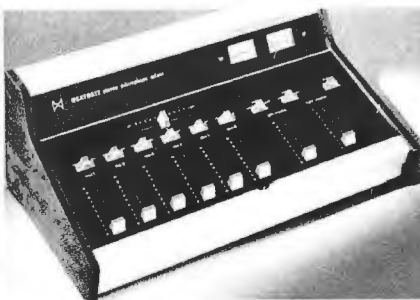
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two LED's with adjustable thresholds. Claimed frequency response is 40-20,000 Hz  $\pm 1\text{ dB}$  with less than 0.5% THD up to 6.5 V output. Overload-resistant inputs are rated at 3.0 V (AUX), 900 mV (HI-Z MIKE) and 60 mV (LO-Z MIKE). \$129.95.

CIRCLE NO. 5 ON FREE INFORMATION CARD

## PALM-SIZE CALCULATOR

Edmund Scientific's electronic calculator (Stock No. 1945) fits in your palm, but has an eight-digit readout with floating decimal, four arithmetic functions, automatic percentage key, lead zero suppression, and a constant key. The unit runs on two 1.5-V Mallory PX 825 camera batteries or equivalent (supplied with calculator). Measures 2.8" x 2" x 0.4" (7.1 x 5.1 x 1 cm) and weighs 2 oz (56.8 g). \$19.95.

CIRCLE NO. 91 ON FREE INFORMATION CARD

## NON-LINEAR SYSTEMS DMM

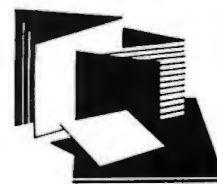
A digital multimeter from Non-Linear Systems, the Model LM-3, offers three-digit readout and can be operated from either battery or line power (NiCd batteries and charger included). Small enough to be held in one hand, it has four ranges of ac and dc volts, and five resistance ranges from 1 kilohm to 1 megohm full-scale. Other features are automatic polarity and automatic zero, 10-megohm input impedance on all ranges, and a 0.33-inch (8.4-mm) LED display. Dimensions are 4" x 2.7" x 1.9" (10.2 x 6.9 x 4.8 cm). \$125.00.

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## TDK HIGH-PERFORMANCE CASSETTE

A new high-fidelity cassette tape, called Super Avilyn, is being introduced by TDK. Avilyn is a patented mix of cobalt, ferric oxide and other proprietary elements. The new tape is said to combine advantages of ferric and chromium tapes, but overcomes inherent problems in both the straight and hybrid formulas currently available. Headwear is said to be the same as that from FeO<sub>3</sub> tapes (much lower than that of CrO<sub>2</sub> formulas). According to TDK, the Avilyn tape has better low- and middle-range response while equalizing the high-frequency response of chromium tapes. Its S/N is 0.5 to 1 dB better than CrO<sub>2</sub>, and can be used with the standard chromium playback equalization time constant of 70  $\mu\text{s}$ . The tape will retail for \$3.95 in C-60 format. A C-90 package will be introduced later.

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# New Literature

## JAMES MILLEN SHIELD DESIGN TIP

"Helpful Hints in the Design of a Magnetic Shield" is a 2-page engineering design tip describing how to shield sensitive devices from interference as well as how to shield devices that cause interference. Thickness and types of shielding materials are discussed, and degaussing procedures are given. Address: James Millen Manufacturing Co., Inc., 150 Exchange St., Malden, MA 02148.

## ALTEC ENCLOSURE DESIGN MANUAL

"Loudspeaker Enclosures—Their Design and Use" is a 32-page manual containing data for use in designing and constructing enclosures for Altec loudspeakers. It discusses the function of the enclosure, speaker design theory, various types of enclosures, and how to tune a bass reflex port. Price is \$2.00. Address: Altec Corp., 1515 S. Manchester, Anaheim, CA 92803.

## NATIONAL CAMERA TOOL CATALOG

The "NC Flasher" (80 pages) includes hard-to-find tools, technicians' supplies, laboratory and workshop equipment, etc. Among new items listed are a low-cost circuit tester, accessories for the "Grabber" test-lead system, and tools and instruments for the photo equipment repair technician. Address: Dept. ORR, National Camera, 2000 W. Union Ave., Englewood, CO 80110.

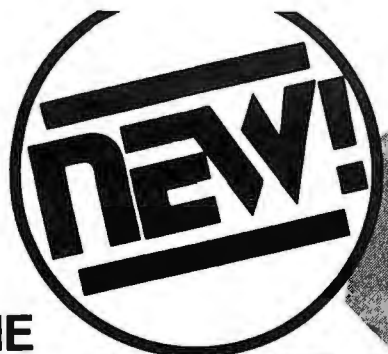
## PROJECTOR-RECORDER BELT CATALOG

A catalog and reference chart from Projector-Recorder Belt Corp. lists over 650 types of belts, wheels, and rubber parts for over 2000 models of audio and video tape players and audio/visual projectors. The company also specializes in servicing belts and other drive parts. Address: Projector-Recorder Belt Corp., 147 Whitewater St., Whitewater, WI 53190.

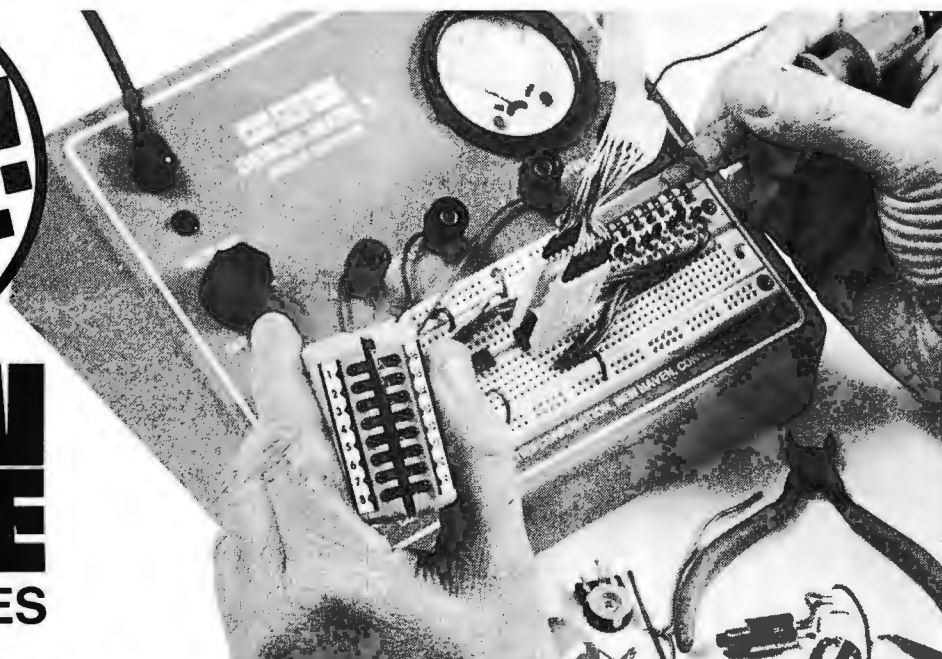
## WOODCRAFTING CATALOG

A 22-page catalog from Garrett Wade Co. describes their line of hardwood workbenches and tools for all types of woodworking projects, including building speaker and hi-fi equipment enclosures and record cabinets. Tools include those for carving, clamping, mitering, and measuring. Workbenches come in a variety of sizes and styles. Address: Garrett Wade Co., Dept. 16, 302 Fifth Ave., New York, NY 10001.





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Now you can build/test electronic circuits **WITHOUT SOLDER** . . . using solid #22 AWG wire to interconnect discrete components . . . resistors, transistors, linear/digital ICs in TO5 or DIP packages (8-40 pins), and more. Plus, you get 5-15VDC up to 600ma (9 watts) of variable regulated power, with a built-in 0-15V voltmeter to monitor internal power and/or external circuits. Now, that's design flexibility! And look at the low, low price!

**49<sup>95</sup>**

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### SPECIFICATIONS

**Power Supply:** Output: 5-15V @ 600ma. Ripple and Noise: less than 20mv @ full load. Load/Line regulation: <1%. Meter: 0-15V DC. Connectors: 1 QT-59S, 2 QT-59B, 2 power supply 5-way binding posts, 2 meter 5-way binding posts. **Wght:** 3 lbs. **Power Needed:** 117V, AC @ 60 Hz 12W.\* **Patent #235,554.**

**64<sup>95</sup>**



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## DESIGN :MATE 2 FUNCTION GENERATOR

Troubleshooting? Design Testing? DM-2 gives you all the signal source capacity you need . . . at a very modest price. This 3-wave form Function Generator has: short-proof output, variable signal amplitude and constant output impedance. Completely wired, tested, calibrated, ready to test audio amplifiers, op-amp and educational lab designs . . . as well as complex industrial lab projects. Complete with easy-to-read instructions/operations manual, application notes, operation theory and more, DM-2 works hand-in-hand with DM-1 for total versatility.

### SPECIFICATIONS

**Frequency Range:** 1Hz-100KHz (5 ranges: 1-10Hz, 10-100Hz, 100-1000Hz, 1-10KHz, 10-100KHz). **Dial Accuracy:** Calibrated @ 10Hz, 100Hz, 1KHz, 10KHz, freq. accurate to 5% of dial setting. **Wave Forms:** Sine <2% THD over freq. range. Triangle wave linearity, <1% over range. Square wave rise/fall <0.5 microseconds — 600Ω-20pF termination. **Output Amplitude:** (all wave forms) variable-0.1V-10V peak to peak into open circuit. **Output Impedance:** 600Ω-constant over ampli./freq. ranges. **Wght:** 2 lbs. **Power Needed:** 117V, AC @ 60Hz 5W.\*

## DESIGN :MATE 3 R/C BRIDGE

Have you been bugged by color codes or unreadable component markings? Forget it! DM-3, the low cost R/C Bridge, measures true component values . . . in seconds . . . to better than 5%. And, it's all done with only 2 operating controls and a unique solid-state null detector, to zero-in on exact component selection . . . instantly! Completely wired, calibrated and tested, DM-3 includes an extensive instruction/applications manual, and operational theory too.

### SPECIFICATIONS

**Resistance Range:** 10Ω-100 megΩ. (6 Ranges: 10-100Ω, 100-1000Ω, 1K-10KΩ, 100K-1 megΩ, 1 megΩ-10 megΩ) **Capacitance Range:** 10pFd-1mFd. (5 Ranges: 10-100 pFd, 100-1000pFd, .001-.01 mFd, .01mFd-1mFd, .1-1mFd.) **Null Detector:** 2 hi-intensity LEDs-hi/lo markings. **Accuracy:** <5% of null dial, range switch setting. **Wght:** 2 lbs. **Power Needed:** 117V, AC @ 60Hz 3W.\*

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Each measures 6.75" L x 7.5" W x 3.25" H.; completely assembled, ready to start testing at once. Order your DESIGN MATEs today!  
\*220V @ 50Hz available at slightly higher cost.

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Among the things you'll discover is how the development of tiny integrated circuits has made possible an electronic calculator small enough to fit into a shirt pocket! And a wristwatch that flashes the time with the push of a button.

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you'll build:

1. A design console, for setting up and examining circuits.
2. A digital multimeter for measuring voltage, resistance and current (it displays its findings in big, clear numbers like a digital clock).
3. A solid-state "triggered sweep" oscilloscope—similar in principle to the kind used in hospital operating rooms to monitor heartbeats. You'll use it to monitor the "heartbeats" of tiny integrated circuits. The "triggered sweep" feature locks in signals for easier observation.

**Step-by-step you'll build and experiment with Bell & Howell's new generation color TV—investigating digital features you've probably never seen before!**

This 25" diagonal color TV has digital features that are likely to appear on all TV's of the future. As you build it you'll probe into the technology behind all-electronic tuning. And into the digital circuitry of channel numbers that appear right on the screen! You'll also build in a remarkable on-the-screen digital clock, that flashes the time in hours, minutes and seconds. Your new skills will enable you to program a special automatic channel selector to skip over "dead" channels and go directly to the channels of your choice.

You'll also gain a better understanding of the exceptional color clarity of the Black Matrix picture tube, as well as a working knowledge of "state of the art" integrated circuitry and the 100% solid-state chassis.

After building and experimenting with this TV, you'll be equipped with the skills that could put you ahead of the field in electronics know-how.

**We try to give more personal attention than other learn-at-home programs.**

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What you really need is the thing you've never lost. A boy's love for exploring. Now you can go again, only this time learning new occupational skills all along the way.

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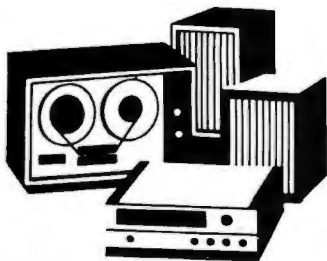
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# Stereo Scene

By Ralph Hodges

## CLEARING UP SOME ODDS AND ENDS

**T**HIS month's column will consist mainly of a few curiosities and conundrums that have kept my mind occupied for the past several weeks, but about which I don't expect to learn much more in the near future. Therefore, it's time to be out with them.

**The Omni Question.** A long-standing controversy surrounds the use of wide-dispersion or omnidirectional ("omni") loudspeakers in stereo installations. The stereo image provided by omni's, say their detractors, is vague, wandering, diffuse, and sometimes grossly distorted (as when a single instrument, which should have a small, sharply localized apparent source, grows to fill much of the space between the speakers). This is usually attributed to the wealth of reflected sound that omni's provide, creating an incalculable number of secondary sound sources in the vicinity of the speakers where the sound bounces off the walls or ceiling.

Reputedly, the true test of a loudspeaker's stereo capability—and it's certainly a theoretically logical one—is whether a pair of them, reproducing an in-phase mono signal, can develop a "stereo" image that is exactly front-and-center and rock solid, with no lateral spread whatever. This is not an easy test for many speaker systems, as it turns out.

Over the years I've come to share some of these misgivings, although not without reservations. For one thing, the anti-omni faction has handed down a blanket indictment of all such speakers, which instinct and experience tell me is unjust. Omni's differ. There is the Walsh-Ohm sort of device that should behave very much like a vertical line radiator and is inherently omnidirectional in the lateral plane. Then there is the distributed-source configuration in which drivers may be studded on all available surfaces of the cabinet. To a real-time

spectrum analyzer integrating over short time increments, these would appear to be very different types of reproducers. To the ear itself, it's hard to predict what distinctions would be apparent.

But my major quibble with the omni detractors is on theoretical grounds. Oh, I know there's often something interesting going on—whether detrimental or not—when omni's are listened to, but I can't make the pat reflected-sound explanation jibe with what I understand to be the workings of the human ear. To enlarge: in the opinion of such august bodies as the Acoustical Society of America, the localization of a transient sound is likely to depend very much on the difference in arrival times of its very first onset at the two ears. If the left ear hears it a fraction of a millisecond before the right ear, then we're led to conclude that the source is somewhere to the left. In the case of sustained sounds for which onset time differences have not done the trick, we seem to depend on interaural phase differences for whatever localization is possible, provided the sound is below about 2,000 Hz. Above 2,000 Hz, which (interestingly) is the point where the wavelengths approach the distance between our ears, amplitude differences between the two ears appear to be dominant.

Now then, stereo is a contrived illusion that is typically achieved in complex ways, but it is certainly safe to say that, in terms of interaural onset-time differences (before any sound reflections have had a chance to reach us), omni's and more conventional speakers start out on an equal footing, and should "image" equally well.

It is true that a later-arriving reflection that is significantly stronger than the onset sound (not an impossibility if a speaker's free-field frequency response varies much at different angles) can overthrow the original lo-

calization, but such difficulties are not inherent in the omni approach. And when we consider phase and intensity differences, the situation is much the same. Properly worked-out omni's should be equivalent in integrity to conventional designs. But there remains another aspect of speaker behavior having to do with "togetherness" that might have some meaning here.

**Time Smear.** Because of the design of most crossover networks, and the nature of the drivers themselves, the separate elements of a multi-way speaker system tend not to respond to an input with equal alacrity. Usually the larger drivers are late, so that an input signal with a steep wavefront, like a square wave, would come out with its frequency components broken down according to which driver was handling them, and spread out over an appreciable time base. Not long ago someone dubbed this phenomenon "time smear"—definitely my favorite jargon phrase of the year—and it became a serious consideration in some speaker-evaluation schemes. The point is that a number of omni speakers, most especially the ones with multiple tweeters arranged so that you hear direct radiations from several of them, are going to exhibit more time smear than the usual case, because some tweeters will inevitably be nearer or farther than others. And, of course, the reflected sound they engender will be correspondingly smeared.

Probably it would be better if speakers didn't have any such anomaly, but since the overwhelming number of available products do, it's appropriate to wonder what audible bad effects it has. That is a subject on which it's hard to find agreement. On a signal (a drum beat, perhaps) that involves together the woofer, midrange, and tweeter(s) in what should be a unison response, we're likely to find some frequencies lagging considerably behind, which will sound not so good or perfectly all right, depending on whether you're talking to one "authority" or another.

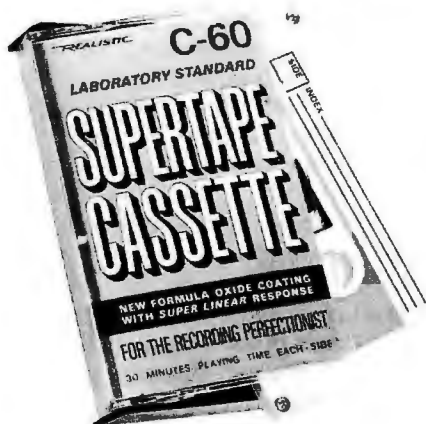
One predictable effect of omni's documented long ago by Haas, is an increase in perceived loudness. The graph (page 24), which I think has implications for many audible phenomena, indicates that the ear integrates over a time "window" of about 100 milliseconds, so that any



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sound of about that duration will sound louder the longer it lasts. The delayed arrivals of sound that are an omni specialty—whether caused by reflections or the layout of the drivers—should bring about an extension of the time the sound lasts at the listener's position. It is to this that I'd attribute some of the bright, open quality (particularly in the high frequencies) that we tend to associate with wide dispersion.

As for time smear over several frequency bands, there is no logical reason for an omni's being at all inferior to a conventional speaker. There is some evidence—all of it quite subjective—for such temporal dislocations' causing a subtle change in perceived tonal balance. For example, some experienced listeners have reported noting tonal changes when they moved off the axis of a conventional speaker so that they were slightly closer to some drivers than others. (Of course, the reports state that all other likely causes of this were eliminated.) Also, several speaker designs, some in existence and others still aborning, take the whole matter very seriously.

Assuming there's substance in any of this, it's interesting to speculate on what portions of the signal would dominate: the leading or the lagging ones? As it happens, few omni designs take these considerations into account, and most would be hard pressed to do so. Ultimately this might prove to be a limitation. As things stand now, however, there might very well be something going on.

**A New Phase.** On a completely different subject, in a conversation with Chuck Wood of Audionics not long ago, I learned of a unique new product that that company is considering. It is an all-pass network that varies the phase of one channel of a phono cartridge, the idea being to get the two channels phase-synchronized as closely as possible and thereby enable your four-channel matrix decoder to

work at its optimum. Harumph, I thought at first, but subsequent investigations have shown a number of cartridges I've checked out to have some phase shift between the two channels. Whether it's enough to be ruinous to matrix-decoder operation I can't say, but my impression is that these boxes need all the help they can get.

**More Demo Records.** My remarks of some months ago on demonstration records have lured a few more contestants out into the open.

Fulton Electronics, among whose products is the FMI Model 80 (considered by many to be in the top rank of under-\$100 speaker systems), also has a small recording operation at its Minneapolis base. Bob Fulton makes records the way I would if I knew how. Of the five Ark (his label) albums I've sampled, none is less than remarkable. One—*Organ Music from Westminster* (a Minneapolis church, not the British institution)—is unique in my listening experience. No light-voiced Baroque instrument this, but one of the high-pressure roarers that has you checking the ceiling overhead for rickety chandeliers. In fact, the specification shows the swell organ to be the largest section of the instrument, which smacks of nineteenth-century excess. Fortunately, the tone of the organ is not hard or piercing, but is almost dominated by the tremendous low-frequency resources—six 16-foot stops and one 32-foot Bourdon. Fulton has gone after these sounds in a way that all but opens the heavens. The bass is as substantial as a brick wall, and it just rolls over you without remission. Yet the rest remains in focus. I recommend the delightful Mozart selection for openers. I also recommend sturdy woofers.

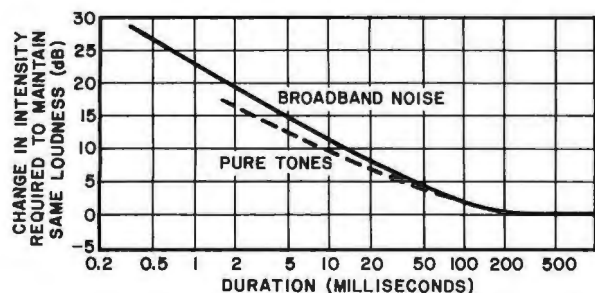
I could be more enthusiastic about Ark's *Organ Sounds from Mount Olivet* if I hadn't heard the *Westminster* first. The *Olivet* recording is more than adequate in the bass, but of greater interest to me is the upper register, which is very strong yet freer of mod-

ulation effects and plain distortion than I'm used to. I should note that, as in the *Westminster*, some of the repertoire is of less than poignant interest, and unfortunately the organist's manner with J.S. Bach, of which there is nearly a full side, tends to be over-methodical.

It is unusual to find a large-scale work such as Bloch's *Sacred Service* as an original recording effort by a small label, but it is available from Ark, paired with Francis Poulenc's *Gloria*, as performed by orchestral and choral forces of the University of Minnesota. Being a two-microphone pickup (fundamental in Mr. Fulton's recording philosophy, I'm told; also, no Dolby processing—I suspect he doesn't believe in it—so all these records hiss), the recording assigns all soloists to the left channel. And, of course, there are no touch-up mikes to highlight orchestral details, if you've become used to that artifact of multi-track recording. The sound that results is extremely attractive and full-bodied, with a "sweetness" (the only word that comes to mind) of the high frequencies that seems characteristic of all the Ark releases (which wears very well for protracted listening). By great good luck, the Minnesota string section seems to have that rarest of talents among nonprofessional groups: the ability to play together and in tune most of the time. All in all, I don't know which large recording outfit you could turn to for so satisfactory a rendition of this music, or any choral-orchestral work.

The repertoire of the *Armstrong High School Choirs* ranges from Renaissance to late-Romantic sentimentality and the inevitable spiritual; but it has taste, and the Armstrong teenagers do crack ensemble with effortless range and dynamics. The recording is close-up and superlative; it should make you feel warm all over, as well as enabling you to hear the words of almost every voice in the group. *Anoka High School Concert Band* (1974) is just as good technically, but it is a high school band—a healthy cut above the troupes that march on New York's Fifth Avenue on St. Patrick's Day, but distinctly troubled at times by the difficulty of the material selected (a transcription of the Berlioz *Roman Festival Overture*, for example). Catalog and prices available from Fulton Electronics, 4428 Zane Ave N., Minneapolis, MN 55422.

Old-time Dixieland is becoming a



*Below 100 ms, short sounds must be more intense to seem as loud as longer sounds. (Courtesy Hewlett-Packard Journal)*



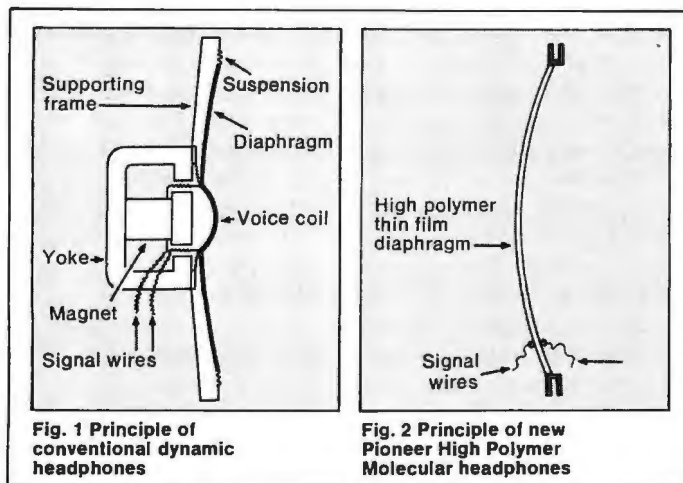
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specialty of Burwen Laboratories, which incidentally manufactures a compander recording system and a dynamic noise filter for playback-only purposes. Burwen's first record (there have been a couple since, I believe) demonstrates the compander with stunning success. The disc, *Perfectly Clear*, presents the East Bay City Jazz Band and vocalist Jane Campedelli in what is said to be a close approach to traditional New Orleans music making. The record is a real wonder. There is not a sound on it that has not been captured with absolute, crystalline precision, and it's fascinating to follow the sharply etched outlines of the brass timbre into the sinuosity of a virtuoso clarinet. The banjo is a bit remote (it "rustles," as the song says), and the drums are really too far away from the mikes, getting soaked up by the extremely dead acoustic of the recording site. But the recording overall has, of course, no tape noise, and no trace of side effects that I could hear from the operation of the compander system. Nor is there any print-through of groove echo. Recorded levels are on the moderate side to accommodate the extreme peaks (which Burwen claims are there and my scope confirms), but the pressing is the flattest piece of vinyl I've seen in years, and exceptionally quiet. If your system will tolerate high gain settings you can blow yourself into chopped liver with this recording and never hear more than a whisper of noise. The Burwen record is \$10.50 from: Burwen Labs, 209 Middlesex Tpke., Burlington, MA 0183.

As promised, Ambiphon provided a new copy of the Natalie Ryshna piano recording that I found too noisy and otherwise unimpressive in my last report. The new pres-

sing is a great improvement—much superior to the earlier one in terms of discrete noises, and perhaps a bit better in hiss level. Listening to it has set my mind working again on the extremely detrimental effects of noise in any listening situation. At first hearing, the dynamic range of the new pressing seemed much better, but in a later direct comparison with the older version it came out about equal. A tricky business this.

Ambiphon also sent a newer recording by the Tequila Mocking Bird Chamber Ensemble. From the name you'd not expect that the group plays Handel, Vivaldi, and Pachelbel straight, but that appears to be the case. However, they attack this material with violin, tuba, and vibraphone. I question whether the vibes achieve a successful blend with the violin, but the tuba generally works well. God knows the bass line is always audible. The recording is very good. The only thing that keeps it from being exceptional is the lack of a big, spacy acoustic and/or spectacular dynamic range. Ambiphon's address is: P.O. Box 341, Kingsbridge Station, Bronx, NY 10463.

In closing, let me announce that CBS Laboratories, now reorganized as CBS Technology Center, is again offering its full range of test records, many of them remastered with newer equipment. The CBS series is especially valuable to the hobbyist because voice-identified spot frequencies are provided along with the more usual sweep tones that require a chart recorder. Thus a good voltmeter will suffice for reasonably accurate frequency-response measurements. For a catalog and price list write: CBS Technology Center, High Ridge Rd., Stamford, CT 06905. ♦

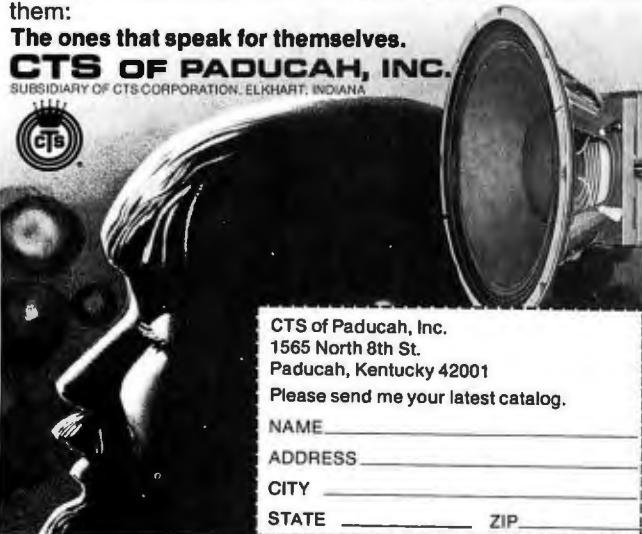
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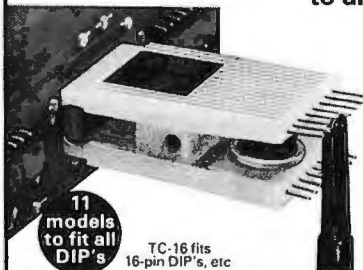
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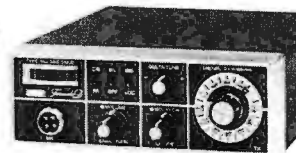
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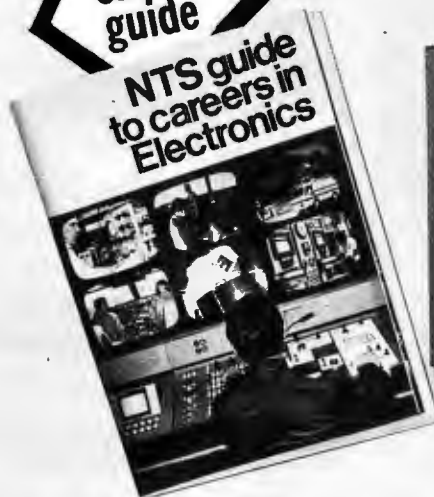
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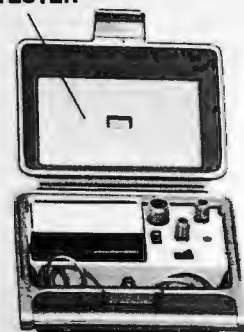
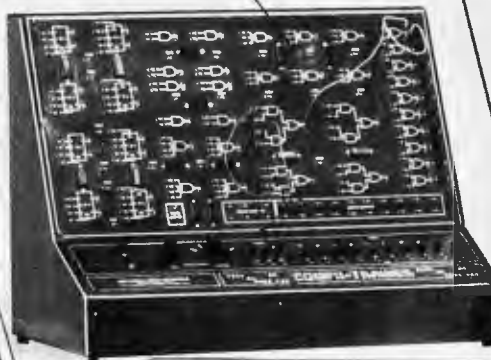
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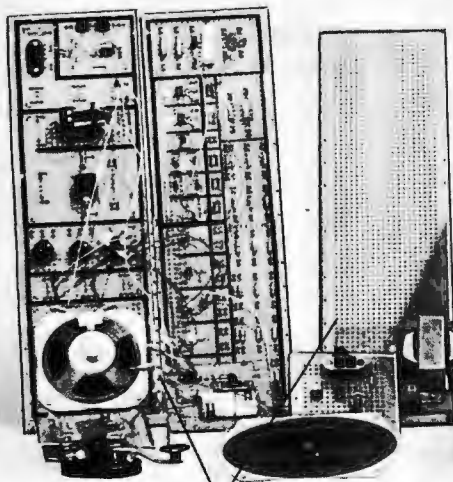


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NOVEMBER, 1975

# The First Motorola/AMI '6800' MPU Computer Project



*Features compact size, simplified construction,  
built-in TTY interface, and low cost.*

BY H. EDWARD ROBERTS & PAUL VAN BAALEN

**L**ARGE-SCALE integration (LSI) has provided many useful IC chips for the hobbyist. One of the latest LSI devices is the microprocessor unit (MPU), which has made it possible to build microcomputers that are fairly easy to assemble at moderate cost. The most popular MPU's are the 8008 and 8080 due to their reasonable cost and wide availability in computer kits.

However, many knowledgeable hobbyists have been looking for a microcomputer built around one of a number of other MPU's available (just as some people would like to try a diesel or steam engine to replace the gasoline motor). Most of these readers have told us they were interested in the Motorola M6800 MPU (for one reason or another). Many also felt that the price of a microcomputer was still too high. POPULAR ELECTRONICS is therefore pleased to introduce the first microcomputer using the 6800 MPU in a design that substantially reduces cost.

**T**HE Altair 680 is a complete microcomputer built around the 6800 MPU available from Motorola and American Micro-Systems, Inc. Measuring a very compact  $11\frac{1}{16}''\text{W} \times 11\frac{1}{16}''\text{D} \times 4\frac{11}{16}''\text{H}$  ( $28.1 \times 28.1 \times 11.9$  cm), the 680 is less than one-third the size of the Altair 8800. Although both computers have MPU's with the same memory capacity, the 680's smaller enclosure makes internal expandability significantly less. However, it is more than adequate for most applications. More importantly, the 680 costs less than half the price of the 8800 when the two machines are configured similarly in a minimum system

Other attributes of the new computer include ease of assembly (only one large pc board), built-in TTY interface, and high speed (4- $\mu\text{s}$  minimum cycle time). The last is some 10 to 50 times faster than earlier small computers built around the 8008 MPU but half the speed of the 8800.

Another meaningful consideration in a 6800-MPU computer design is the raft of instructional material readily available from Motorola Semiconductor Products, Inc., including the "M6800 Microprocessor Programming Manual." Too, the 6800 is TTL compatible and uses just one 5-volt power supply.





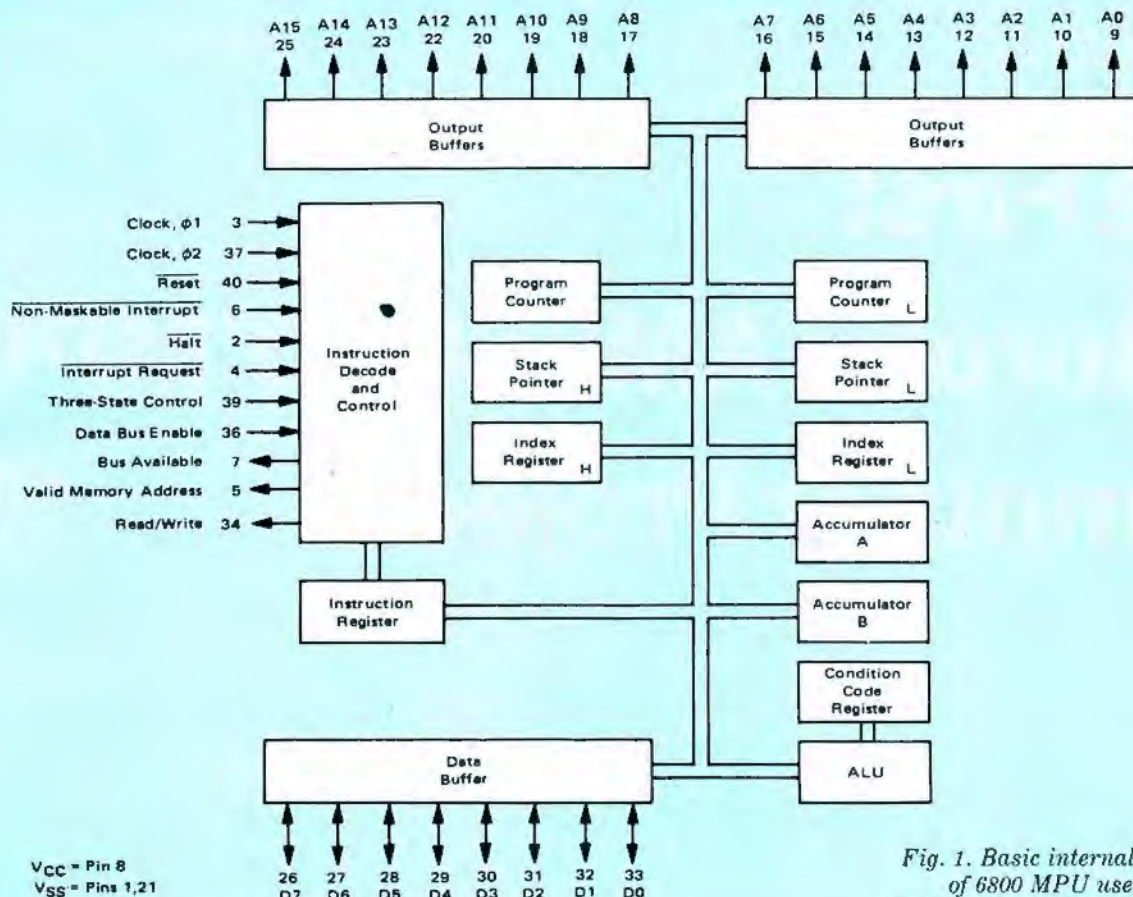


Fig. 1. Basic internal arrangement of 6800 MPU used in computer is shown here in block-diagram form.

**Basic System Philosophy.** The basic MPU, memory, I/O (input/output), and power-supply circuits in the Altair 680 are located on a single printed circuit board. The addition of a compact power transformer makes this assembly a complete computer system. (Front-panel switch programming can be used, but in the absence of this assembly, PROM's or ROM's must be installed for programming.)

The front-panel assembly contains all the logic needed to reset, halt, or start the processor. Also, any memory cell can be read or written into from the front panel via 16 ADDRESS and eight DATA switches. Mounted on the front-panel circuit board is a 100-contact edge connector that permits the main MPU board to plug directly into the front panel, thus eliminating the need for a wiring harness. (In systems that do not use the front-panel assembly, the MPU board automatically starts running at an address specified by either a PROM or a hard-wired patch.) The front panel contains 27 LED's that indicate the state of each switch. As a safety measure, the POWER switch is located on

the back of the cabinet to obviate the possibility of its being accidentally operated during programming.

The basic computer contains 1024 bytes of memory and has provisions for an additional 1024 bytes of PROM or ROM memory. An I/O channel and interface are also included in the basic system. The I/O channel can be configured to interface RS-232 or a 20-mA or 60-mA TTY loop. This means that anyone who can obtain an old five-level Baudot-type Teletype—such as the MOD-15, MOD-19, etc.—can use it as a computer terminal. (Many such Teletypes are available for less than \$100 and frequently for as little as \$25 nationwide.)

The Altair 680 can be built with either a full-programmability or a "turn-key" front panel. The latter eliminates all controls except restarting the processor. There are a number of applications where this is desirable to eliminate the possibility of having an operator affect the contents of the memory or the computing cycle. An example might be in a sophisticated intruder-detection system where the only control provided for the operator is essentially on/off.

**Software.** The software associated with the 6800 MPU includes an editor, PROM monitor, and assembler, as contrasted to the editor, assembler, monitor and basic for the Altair 8800 computer.

**System Details.** The Altair 680 computer is composed of five sections: MPU and clock, memory, control and indication, I/O port, and power supply.

**MPU and Clock.** As mentioned earlier, the MPU and clock are the new 6800 LSI chip. Its basic internal arrangement is shown in Fig. 1. The main elements are instruction decode and control, instruction register, data and address registers and buffers, 16-bit index register, 16-bit program counter, 16-bit stack pointer, two 8-bit accumulators, condition code register, and ALU (arithmetic logic unit).

The timing and control inputs and outputs for the 6800 chip are:

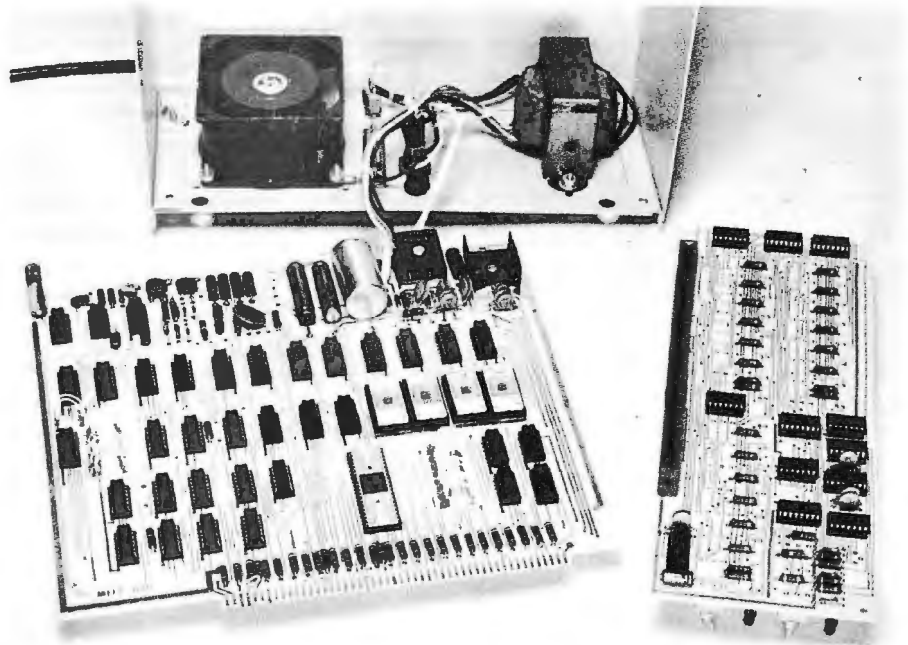
Phase 1 and phase 2 clock ( $\phi 1, \phi 2$ )—a nonoverlapping 500-kHz clock at  $V_{cc}$ .

Address bus A0 through A15—16 high active outputs that determine address or I/O sections to use.



## DISPLAY PARTS LIST

C1,C4—0.33- $\mu$ F, 12-V disc ceramic capacitor  
 C2,C3—0.47- $\mu$ F, 12-V disc ceramic capacitor  
 DA00 to DA15, DD00 to DD07, and DS1 to DS3—RL21 light-emitting diode  
 ICA,ICB,ICC,ICD,ICE,ICF,ICG,ICH—4449  
 ICJ—74L00  
 ICK,ICL—26L123  
 Following resistors are 1/2-watt, 5%:  
 R1 to R16,R20 to R27—1500 ohms  
 R17 to R19—20,000 ohms  
 R28 to R30,R33 to R37—4700 ohms  
 R31 to R38—1000 ohms  
 R39,R40—10,000 ohms  
 SC1 to SC12—0.1- $\mu$ F, 12-V disc ceramic capacitor  
 SA00 to SA15,SD00 to SD07,S24—Spdt toggle switch  
 S26,S27—Spdt momentary toggle switch  
 Misc.—100-contact edge connector



*Almost entire computer is assembled on a single large pc board (left). Board at right is for front panel. Boards plug together.*

Data bus D0 through D7—eight high active bidirectional lines for transfer to and from memory and peripherals.

Halt signal ( $\overline{\text{HLT}}$ )—low active input that ceases activity in the computer.

Read/write signal (R/W)—in the high state, signals the memory and peripherals that the MPU is in the read condition; in the low state, signals that the MPU is in the write condition.

Valid memory address (VMA)—signals external devices (memory and I/O) that the MPU has a valid address on the memory bus.

Data bus enable (DBE)—enables the bus drivers.

Bus available (BA)—indicates machine has stopped and address bus is available.

Reset ( $\overline{\text{RES}}$ )—resets and starts the MPU from a power-off condition. A positive-going edge on this input tells the MPU to begin the restart sequence.

Interrupt request ( $\overline{\text{IRQ}}$ )—when low, tells the MPU to start an interrupt sequence (save the registers on the stack, set interrupt mask bit high so no other interrupts can occur, and vector to the interrupt address). This type of interrupt can only occur if the interrupt mask bit in the condition code register is low.

Nonmaskable interrupt ( $\overline{\text{NMI}}$ )—

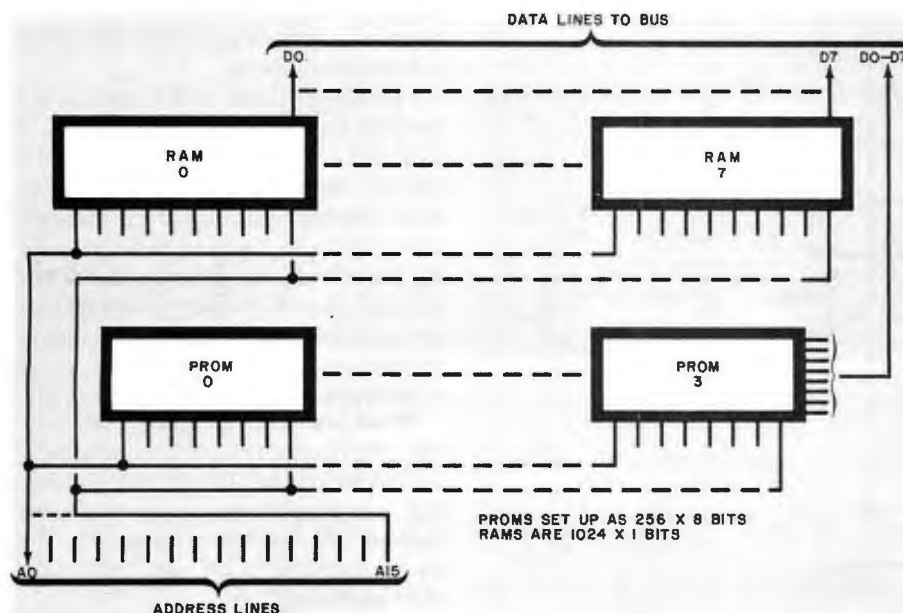
essentially the same as the  $\overline{\text{IRQ}}$ , except it is not dependent on the condition code register.

The clock is a 2-MHz crystal-controlled oscillator that uses a pair of inverters that drive flip-flops to form a 500-kHz, two-phase clock that is distributed to the MPU, memory, and I/O sections in the computer via inverters and buffers.

**Memory.** The memory system consists of 1024 words of 8-bit-wide RAM, using 2102-type 1024  $\times$  1-bit devices, and up to 1024 words of PROM, using ultraviolet-erasable 1702 devices. The basic arrangement is shown in Fig. 2. The low-order address bits are fed to both the RAM's and PROM's.

**Front Panel.** The front panel assembly contains the RUN/HALT switch, with a LED for each switch position; a reset switch with no LED indicator; and the ac power ON LED indicator (Fig. 3). The 16 ADDRESS switches and eight DATA switches each have their own LED indicator.

The DEPOSIT, RESET, DATA, and ADDRESS switches are enabled only when the RUN/HALT switch is in the HALT position, at which time, a retriggerable one-shot multivibrator drives the halt input of the MPU low. This, in turn, drives the bus-available (BA) signal high and also conditions the other switches. To view the data in any memory location, the RUN/HALT switch must be placed in the HALT position and the ADDRESS switches set to the required address. The data at that



*Fig. 2. There are eight RAM's (RAM 0 through RAM 7) and four PROM's (PROM 0 through PROM 3) in the computer's memory system.*

# ALTAIR COMPUTER COMPARISON CHART

Features	Altair 680	Altair 8800
Maximum word size	24 bits (byte oriented)	24 bits (byte oriented)
Arithmetic unit	8-bit parallel	8-bit parallel
Minimum cycle time	4 $\mu$ s	2 $\mu$ s
Program instructions	72	78
Maximum memory size	65k bytes	65k bytes
Internal expandability	5 interface cards	250 interface cards
Interrupt	3 levels	8 levels
MPU	6800 (Motorola, AMI)	8080 (Intel, TI)
Approximate system cost (1k memory, I/O, case, P/S)	\$300	\$600
Miscellaneous	Fewer parts 2 printed circuit boards Smaller size Built-in TTY interface	Minimum of 4 pc boards

## MAIN BOARD PARTS LIST

BD1—Bridge rectifier (VJ048)  
C1—3300- $\mu$ F, 50-V electrolytic capacitor  
C2,C3—100- $\mu$ F, 50-V electrolytic capacitor  
C4 to C9—0.33- $\mu$ F, 50-V disc ceramic capacitor  
C10,C13—0.1- $\mu$ F, 16-V disc capacitor  
C11,C12—0.33- $\mu$ F, 16-V disc capacitor  
C14—0.01- $\mu$ F, 16-V disc capacitor  
C15—1- $\mu$ F, 50-V electrolytic capacitor  
D1,D2,D7 to D12—1N4004 diode  
D3 to D6—1N4739A, 9.1-V zener diode  
F1—1-A, 250-V ac, 3-AG fuse  
ICA—7404  
ICB—7473  
ICC,ICUU—7408  
ICD,ICE,ICS—4449  
ICF,ICG—74LS01  
ICH,ICJ,ICK,ICL,ICM,ICN,ICP,  
ICR—2102  
ICT,ICU,ICGG,ICHH,ICPP,  
ICRR—74LS30

ICV—74L00  
ICW—74L74  
ICX,ICY,ICTT—4050  
ICZ,ICAA,ICBB,ICCC—1702  
ICDD,ICFF—74L04  
ICEE,ICMM—74L10  
ICJJ—6800  
ICKK,ICLL,ICSS—74LS05  
ICNN—74LS27  
Q1,Q3,Q4—TIS98  
Q2—EN3907  
Except where noted, following resistors  
are  $\frac{1}{2}$ -watt, 5%:  
R1,R2—33 ohms, 2-watt, 5%  
R3,R4,R5,R7—100 ohms  
R6—130 ohms, 1-watt, 5%  
R8,R11—800 ohms  
R9—220 ohms, 1-watt, 5%  
R10,R28 to R51—7500 ohms  
R12,R15,R16,R17—1000 ohms  
R13—470 ohms  
R14,R20,R21—390 ohms  
R18,R19—330 ohms  
R22—33,000 ohms  
R23,R24,R25,R60—10,000 ohms

R26,R27,R56,R57,R58,R59—not used  
R52 to R55—3000 ohms  
SP1—Spdt toggle switch  
T1—5-volt, 1.2-A transformer  
VR1—7805 regulator  
XTAL—2-MHz crystal  
Misc.—Fuse holder (Buss HKP-CC, line  
cord, fan (1MC 3 $\frac{3}{8}$ "), I/O socket  
(DB-25S), sockets (14-pin, 22; 16-pin, 20;  
24-pin, 4; 40-pin, 1), case optional).  
Note—The following are available from  
MITS, 6328 Linn, N.E., Albuquerque,  
NM 87108: complete kit (all parts)  
#680F at \$293; complete kit except for  
front panel board #680T at \$240; kit  
#680MPU, including pc board, 6800  
MPU, 1k memory, and all main board  
components except power supply at  
\$180; front panel and MPU pc boards  
#680PC at \$48; I/O socket kit at \$29; fan  
kit at \$16; 256 x 8-bit PROM kit at \$42;  
construction information package is  
free, with self-addressed stamped 9" x  
12" envelope.

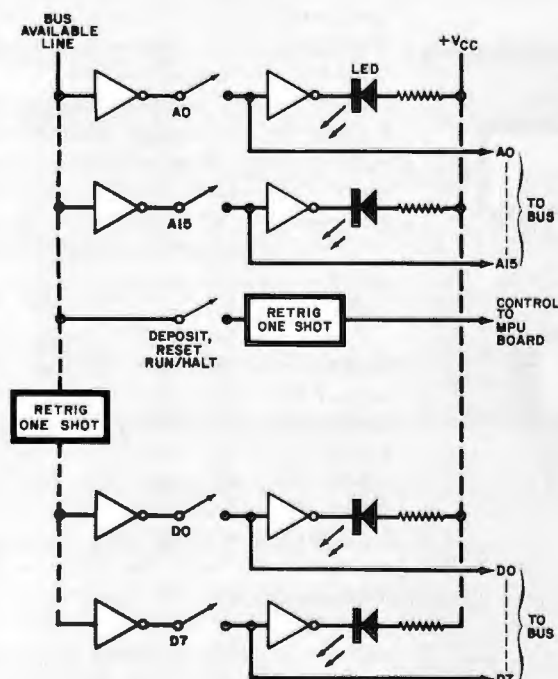


Fig. 3. Front panel contains address and data switches A0 through A15 and D0 through D7, reset switch, and LED indicators.

memory address location will then appear as lighted and unlighted LED's in the DATA display.

To change data in a location, the desired data is written via the DATA switches and entered by operating the DEPOSIT switch. This triggers a one-shot multivibrator, enabling the data information to the data bus and causing the  $R/\overline{W}$  signal to go low. Since the address bus is already connected to the switches by being in the halt state, the write pulse causes the data to be written into the selected RAM address.

When the RESET switch is operated, the CPU resets. This, in turn, initiates a restart sequence. That is, the address bus is pulled to the high state and causes the hard-wired data in the board jumpers to be used as the restart address.

Access to the I/O port is gained by addressing location 17577 (in octal). A sequence of events then occurs that



causes an output to the built-in TTY output jack and at the Teletype itself.

**Power Supply.** The main 5-volt line is generated within the computer by a conventional bridge rectifier, filter capacitor, and IC regulator circuit. A 32-volt winding on the transformer is used to generate the unregulated  $\pm 16$  volts required for the TTY interface system, while a  $-16$ -volt line is fed to

four zener-diode-regulated outputs to provide four 9-volt lines for the PROM's.

**Construction.** The actual-size etching and drilling guides for the computer boards are larger than our page size. Rather than reducing or cutting them up to fit our pages, a free construction package is available. If you

wish to obtain a construction information package, simply send a self-addressed stamped 9" x 12" envelope to the address given at the end of the Parts List.

The construction package contains full-size schematics, full-size etching and drilling guides, component-placement diagrams, and front-panel layout. ♦

## CRAMER ELECTRONICS ENTERS OEM COMPUTER KIT MARKET

**T**HE major reason for the tremendous success of the various computer kits on the market is that they save considerable time. One doesn't have to hunt down the MPU's, memories, etc., that must be accumulated before embarking on a home computer project. It appears that OEM engineers are also spending considerable time in hunting down computer parts. Cramer Electronics, one of the leading U.S. electronic parts distributors, has decided to enter the computer kit business, with emphasis on the OEM market.

Cramer is starting with three kits, separately based on the Intel 8080, Motorola 6800, and Texas Instruments TMS8080 MPU's. Each of the kits

shares a common \$495 price tag.

You get a lot for \$495: complete color-coded schematic diagram; RAM with 1024 (8-bit) bytes, expandable to 65 k bytes; erasable PROM with 1024 (8-bit) bytes; support circuitry, including clock, complete buffering, control and synchronization logic, interrupts, DMA controls; etc. The PROM gives you a program to run at the outset. There are at least four 8-bit-wide input and output ports, with expandability to 512 ports, decoding for 16 of which is included.

The PROM contains a system monitor to permit the computer to be used as soon as it is assembled. Programs can be entered, modified, examined, and executed under switch

control or by typed-in commands. A cassette program, included with the kit, can be used to debug the computer. Finally, a complete user manual gives hints on programming and how to expand the computer.

All together, there are about 190 parts in each kit, adding up to a total catalog value of some \$700. Software is included in the kits to help in programming via front-panel switches and LED's, cassette tape, Teletypewriter, or any RS-232-compatible terminal. Not supplied are printed circuit boards, power supply, and cabinet.

For more information about the new computer kits, write to: Cramer Electronics, Inc., 65 Wells Ave., Newton, MA 02159. ♦

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*At bottom right in photo is RCA's VideoDisc player. Engineer is holding typical 12" VideoDisc.*

# HERE COME THE HOME VIDEO DISCS

*How the three leading video disc systems produce sight and sound from a disc resembling the familiar LP record*

**BY KEN WINSLOW**

**A**FTER several false starts with magnetic tape and optical film and expensive equipment, a practical home-entertainment video playback system that can be used with any TV receiver is on the horizon. RCA, AEG

Telefunken, British Decca, Zenith Radio, N.V. Philips, MCA, Thomson CSF, and others have developed video disc systems, that resemble and can be played like an audio disc. More important, the decks and program

material are relatively inexpensive compared to tape and optical film systems.

If the developers have their way, we will no longer be tied to network and local station programming. Soon,



we'll be able to make our own choices of prerecorded video disc color TV programs. In fact, West Germans can now buy a video disc player from a local retailer. They can also choose from an initial selection of 200 video disc programs.

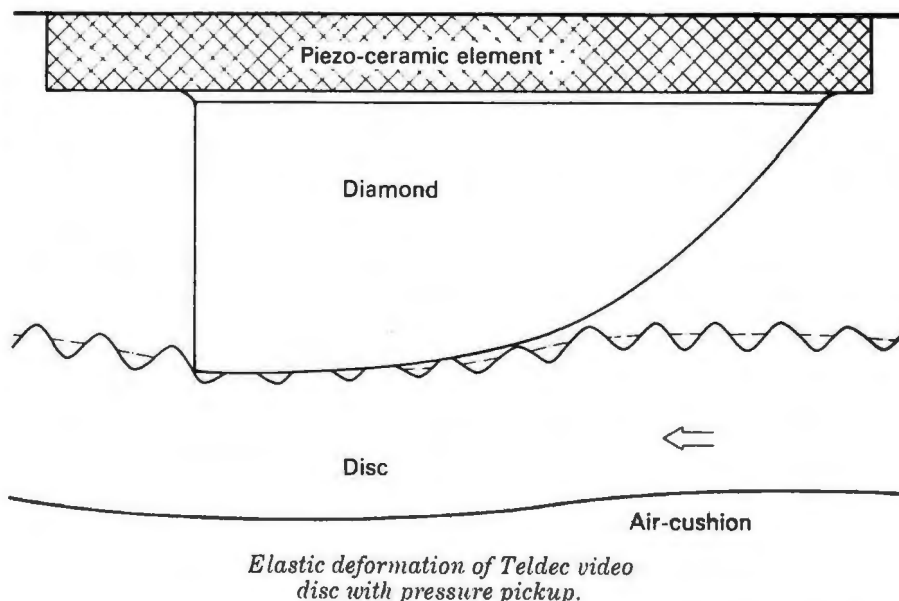
By the end of 1976, it appears that there will be two incompatible systems (produced by RCA and Philips/MCA) in competition for the U.S. consumer dollar. There is also the possibility that other systems, such as West Germany's Teldec system, will join the battle.

**The Video Discs.** Similar in physical appearance to and played in essentially the same manner as the 12" LP audio record, the video disc will offer just about every form of entertainment imaginable—from motion pictures to plays to opera and even informational and educational programs. Some manufacturers are busily trying to obtain the rights to current-run motion pictures. One manufacturer (Philips/MCA) plans to provide text—illustrations and print—materials that permit the user to scan or read single pages forward, backward, or at random simply by pressing a pushbutton switch.

Although a video disc might look like an audio disc, the similarity is only superficial. By modern high-fidelity audio recording standards, the transient flow of information bits dealt with is calculated to be 300,000 bits/second. Consequently, LP records have the ability to accommodate a density of about 5,000 bits/square millimeter. The result is that a 33 $\frac{1}{3}$  rpm LP disc can easily accommodate 30 to 45 minutes of audio program signal.

The transient information flow required to present a TV picture today is about 100 times more intense than that of sound transmission. A storage medium with the information-density capacity of a video disc would have to offer 100 times more capacity in the same or enlarged surface area for recording the same length (in time) program in video as it does in audio.

An ever-widening variety of dense storage and retrieval techniques and technologies for use with a reasonably sized disc have been demonstrated since 1970. Three leading methods—from RCA, Teldec (Telefunken/Decca), and Philips/MCA—have emerged as of this writing. Because it is the only system currently



available, we will take a detailed look at Teldec's pioneering work as an example of the problems faced and as a means for comparing the different solutions to the problems. (Teldec's "TeD" system, a cooperative effort between AEG-Telefunken and British Decca, first demonstrated its solution to dense storage technology with a working monochrome system in June 1970.)

The standard LP audio disc contains 250 to 350 grooves/radial inch, with information recovery dependent upon a side-to-side (lateral) stylus excursion. Teldec discovered that, by adopting a frequency-modulation carrier oscillation technique, a single cutting amplitude could be employed during disc mastering to handle the full required frequency range of the video and audio signals within a constant track width. This also permitted the use of an up-and-down (vertical)

stylus excursion method for signal information recovery. Teldec was able to almost eliminate the guard space allowance between the tracks, with the result of raising the number of tracks to 3500/radial inch. This gave the needed 100-fold increase in storage capacity from the same surface area used in audio discs, and it made possible a 12" disc.

The problems of TV's high-frequency range and dense information storage encountered in making the recorded video disc are similarly overcome in retrieving the information from the disc. The stylus for an LP can easily respond as mechanical movement at audio frequencies. However, the mass of the stylus of an audio cartridge is too great to permit such response at the much higher TV frequencies. Needless to say, the various companies have solved the problem in their own special ways.

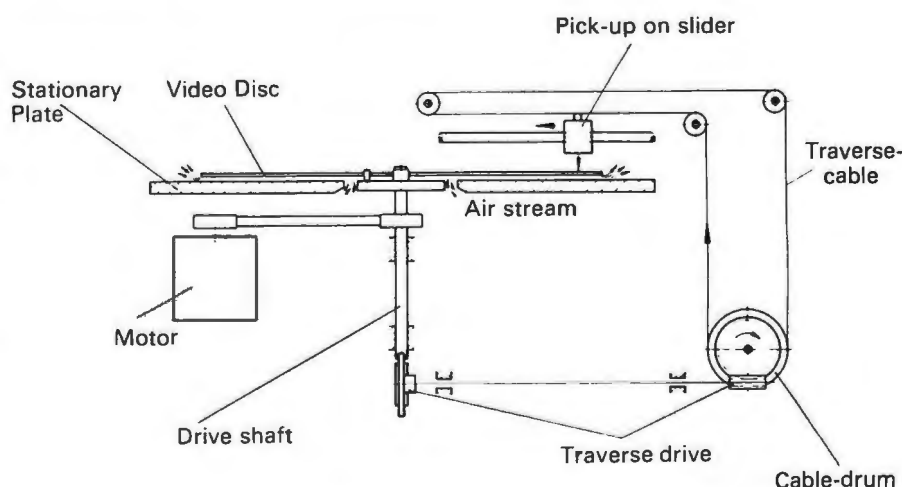


Diagram shows mechanical details of Teldec's disc drive and signal pickup system.

**Teldec's "Stylus" Player.** In the Teldec system, the information is recorded as deformations in the groove track over which a diamond rides and is sensed as changes in pressure. The stylus tip is in the shape of a sled runner with a gradual radius on the leading edge (relative to disc rotation) and a sharp trailing edge. During playback, the leading edge glides smoothly along the groove over the deformations without damaging them. As the deformations move under the stylus, they become compressed. The sharp trailing edge of the stylus runner passes over the compressed deformations, causing them to spring back to their original shape. In doing so, the signal on the stylus is registered as a constantly varying pressure. The diamond stylus is rigidly fixed to a piezoceramic element that converts pressure variations into electrical picture and sound signals. The sound, recorded in the same fashion as the video, is recovered as pulses that appear during the blanking interval between horizontal line scans.

Consisting of 30 frames/second (equivalent U.S. standards), Teldec's color TV picture is recorded on the disc with each frame occupying one full rotation of the disc. The disc must

rotate at 1800 rpm, which is readily accomplished in synchronization with the power line frequency. Rather than riding on a conventional turntable, the disc is center-positioned on a spindle and is supported on a cushion of air above a stationary platter. Instead of being freely guided by the groove, as with an LP, the video disc's stylus assembly traverses the disc's surface by a simple drum, cable, and pulley arrangement run by the same motor that turns the disc spindle. (The easily scratched disc is not handled by the user. An automatic mechanism extracts it from the protective envelope and returns it after play when the envelope is inserted into the machine by the operator.)

The entire player, with its electrical circuits, is about the size of a large briefcase. It is independent of the TV receiver, providing a modulated r-f sound-and-picture signal on an unused channel through the receiver's antenna terminals.

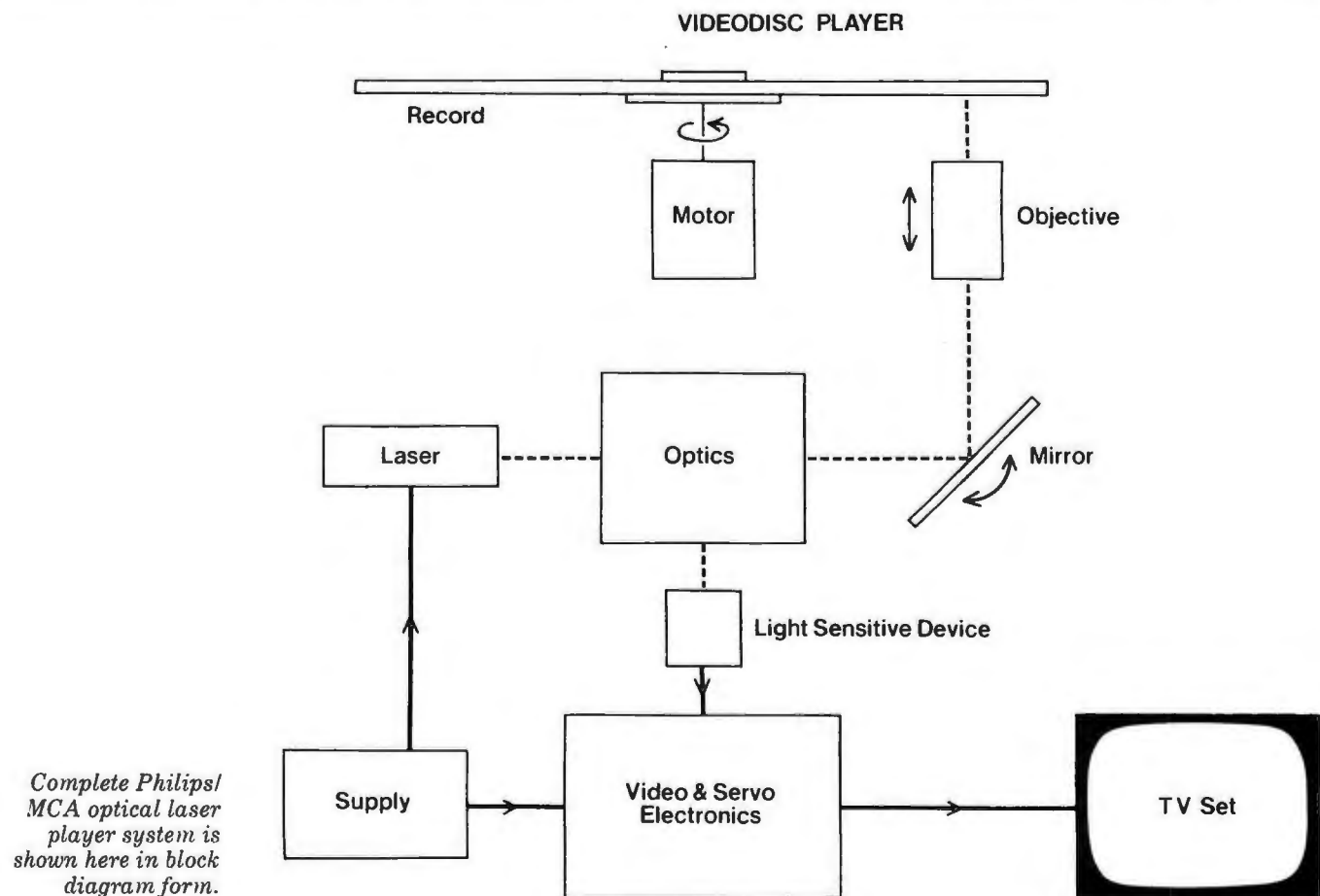
As the system is currently designed, Teldec's video disc has a playing time of 10 minutes.

**P/M's Laser Player.** Philips/MCA and RCA have taken the video disc considerably further than Teldec has

to date in terms of playing time. Both companies pack greater numbers of grooves to each inch on their disc. Also, both have developed their own unique information recovery transducer systems that are said to be less expensive per hour of use, cause less wear on the disc, and have longer operating lives. Their discs are also designed to be more rugged and easier to handle than are Teldec's.

N.V. Philips and MCA initially pursued separate development of laser/optical systems but have recently combined their efforts. In March of this year, an impressive demonstration of the joint venture was given. Magnavox, now a subsidiary of North American Philips, is said to be planning to manufacture a U.S. P/M video disc player by the fourth quarter of 1976. The large entertainment conglomerate of MCA will be handling programming and disc mastering and replication for the U.S. market.

The P/M system employs a very precisely controlled laser beam to record information on and recover it from the video disc. In recording, a laser is used to cut minute oblong depressions that represent sound, color, and brightness information. About 0.7-micron wide, the depressions vary by 0.8 to 2.5





microns in length and follow a continuous spiral path. Because of this extremely small size and the fact that the tracks can be spaced less than 2 microns apart, P/M is able to achieve about 12,500 tracks per radial inch. This is almost three times more than is possible with the Teldec approach.

The P/M disc consists of three parts: protective layer, information layer, and highly reflective layer of aluminum.

A laser beam in the player is used as a non-contact optical "reader" to recover audio and video information from the disc. Light from a 1-mW helium-neon laser is focused onto the video disc as a spot 1 micron in diameter. This is reflected back from the aluminum layer through a recovery lens that focuses it on a photo detector. The detector converts the beam into an electronic sound-and-picture signal. The spot of light follows the rotating track and intercepts the depressions that contain the video information. As the light rides over each track depression, the amount of light

reflected back is modulated by the length/depth characteristics of the depressions.

A number of different control and servo systems perform various functions: to select and preserve accurate spot tracking and focus; to maintain time-base stability in case of unevenness of the disc surface due to ir-

regularities or warping and center-hole location eccentricities; and to ignore the accumulation of surface dirt and scratches on the protective transparent coating. Since there is no stylus or physical contact with the disc, the P/M player is a "no-wear" system, and the video disc should theoretically last forever.



Philips/MCA player has controls located on front panel. To left of center is slide-type slow-motion control. Remaining controls on panel are pushbuttons.

## NOW!...THE SON OF MEMORY TRANSLATOR...

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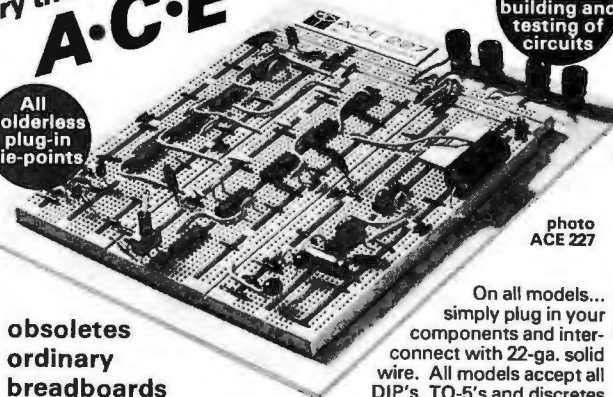


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The disc rotates at 1800 rpm. As a consequence of the 30-frame/second U.S. NTSC TV system, the disc makes one revolution of 360° for each frame. A radial deflection mirror forms part of the laser beam control system. P/M says that the radial deflecting mirror can easily be made to control the beam during the vertical interval to repeat the same track, jump back one or more tracks, or jump forward one or more tracks. Since this occurs during the vertical blanking period of the frame, and provided that not too big a jump is made during this limited time, all manner of still, fixed, and variable slow forward and reverse motion, and random-access effects can be obtained by "playing" the controls. A digital index counter is used to help pinpoint the location of a specific selection or frame.

The disc will be single-sided and will contain up to 30 minutes of program material. Company spokesmen say that they will be able to meet the announced price of \$500 for the player and still be able to offer the stop/slow/variable-frame display system that the player seems so uniquely able to provide.

As announced, the P/M player will offer modulated r-f picture and sound signals through the antenna input of any conventional TV receiver. Two separate 15,000-Hz audio output channels will also be provided for feeding into a stereo audio system.

**RCA's "Capacitive" Player.** In a number of respects, RCA's capacitive-mechanical video disc sys-

## VIDEO DISC SYSTEM COMPARISON CHART

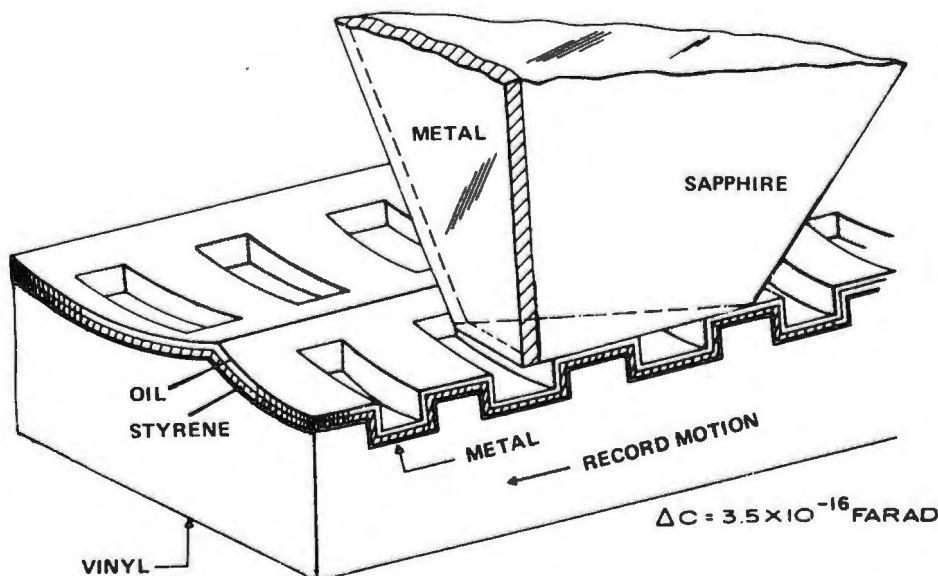
	TELDEC	PHILIPS/MCA	RCA
<b>DISC:</b>			
Composition	PVC	Mylar/reflective aluminum	vinyl/metal dielectric/oil
Diameter	8"-10"	8", 12"	12"
Playing time	10 min.	30 min.	60 min. (2 sides)
Speed	1800 rpm	1800 rpm	450 rpm
Tracks/inch	3500	12,500	5555
Information scheme	groove deformations	long longitudinal pits	transverse slots in grooves
Average life	100 plays (min.)	indefinite	100 plays (min.)
Estimated cost	\$4-\$10/disc	\$2-\$10/program	\$10/disc
<b>PLAYER:</b>			
System type/transducer	mechanical contact/pressure	no-contact/optical laser	mechanical contact/capacitive
Estimated price	\$500	\$500	\$400
<b>PICKUP:</b>			
Type	diamond stylus	laser	sapphire stylus
Estimated life	70-100 hours	NA	200 hours (min.)
Replacement price	NA	NA	less than \$10 for stylus/cartridge assembly

NA = Information not available at this writing.

tem falls between the Teldec and P/M systems in terms of storage-density and playing capability. RCA spokesmen say that a calculated choice was made to design a system that offers a player/disc component system that keeps the difficult parts in the factory

and the noncritical parts in the home. By using a stylus tracking system, a capacitive-sensing signal-detection technique, and a 450-rpm disc speed, RCA believes it has struck the best possible balance in manufacturing, reliability, operational simplicity, low purchase/operating cost, and duration of available playing time. Except for the stylus assembly, the company states that the electrical and mechanical assemblies for the player are largely off-the-shelf items.

Similar to Teldec and unlike P/M, RCA uses a grooved disc that mechanically guides the stylus over the signal track. The grooves are spaced 4.57 microns apart (center to center). There are 5555 grooves per radial inch. The disc itself consists of five layers of material sandwiched together. The vinyl core contains the information slots that vary in length between 0.23 and 1.23 microns. (The slots are cut in the master by a high-resolution electron beam in a vacuum chamber.) Metallic and styrene coatings are then applied to both sides of the disc. Finally, a layer of oil that increases the life expectancy of both the



Detail view of RCA's stylus tip and cutaway view of VideoDisc surface. Metal layers on disc and sapphire stylus form two plates of capacitive element.



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Model BM-1335

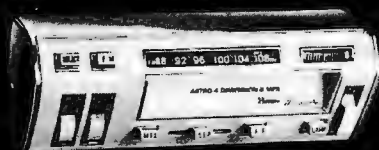
## In-Dash Matrix Quad 8-Track Stereo Tape Player with AM/FM Stereo Radio



Features: 5 pushbuttons for AM or FM station selection; fully adjustable shafts for custom installation; positive action slide switches for AM-FM and 2/4 channel quad sound; pushbutton cartridge eject; MPX (stereo) indicator beacon; digital program readout lamps; non-protruding safety cartridge position.

Model BM-1150

## Under-Dash Matrix Quad/Stereo 8-Track Tape Player with FM Stereo Radio



Features: 4-channel matrix system separates 2 channel stereo reception into 4 distinct parts for full dimensional sound; fast forward selection; digital program read-out lamps; slide balance control; tape eject button; tape reading lamp; burglar alarm system.

Model BM-1950

## In-Dash Digital Clock/AM/FM MPX Stereo Radio

There's only one AM/FM stereo radio with built-in digital clock, and this is it. Features: large digital readout time piece; solid state and integrated circuitry; FM stereo indicator beacon; quick-set adjustable shafts; vinyl padded faceplate; in-dash installation (under dash also); built-in AFC (Automatic Frequency Control); easy access time setting control.

## In-Dash AM-FM-MPX (Stereo) Radio/8-Track Tape Player



Features: cartridge compartment head adjustment; AM-FM slide bar selector; pushbutton cartridge door; Mono-Stereo slide control; pushbutton local-distance sensitivity control; cartridge compartment Antenna Trimmer; multicolored program indicator beacons.

Model BM-1125



The Model BM-1125 incorporates a new technological advancement in car stereo electronics—an illuminated radio dial in the tape cartridge door. This unit is not just an outstanding AM-FM-MPX Radio. When an 8-Track cartridge is inserted into the tape door the radio dial hinges back, out of the way, and your Stereo Radio becomes an 8-Track Stereo Tape Player.

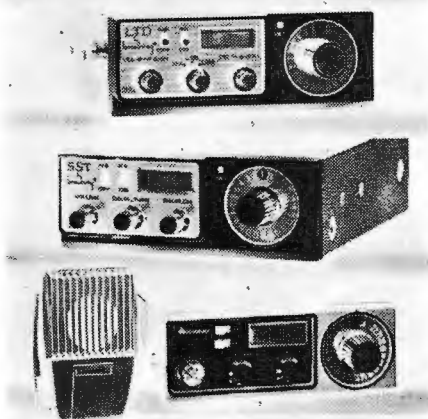
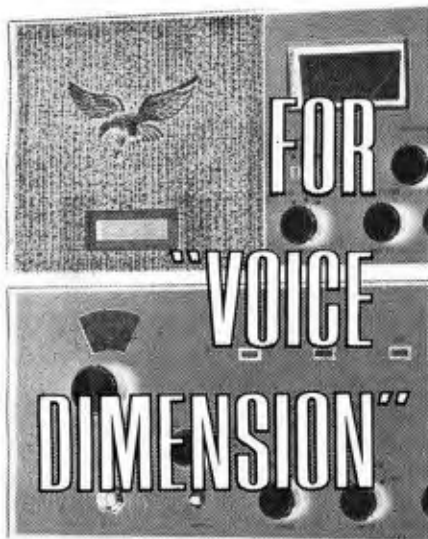
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disc and the stylus is applied to both sides of the disc.

The signal is recovered from the disc by capacitively sensing the information elements pressed as transverse slots in the groove. A plow-shaped sapphire stylus, when in contact with the groove, extends about 3 to 10 microns along the groove. A thin coating of metal on the flat trailing edge of the stylus serves as one plate of a capacitor, while the metallic layer in the disc represents the other plate. The styrene coating on the disc serves as the capacitor's dielectric.

As the stylus travels along the groove over the information slots, the capacitive voltage relationship between the insulated plates fluctuates by amounts that depend on whether or not the area immediately beneath the stylus is or is not a slot cavity. The changing capacitance is sensed by a tuned circuit, of which the stylus "plate" is one element, thereby providing the signal information for amplification and processing into a standard video/audio signal.

Variations in disc speed caused by power-line frequency fluctuations, as well as disc imperfections caused by warping and centering problems, must be corrected to insure a steady, fault-free picture. While P/M uses various compensating servo loops, RCA says it has made a special design effort to keep such complexity, with corresponding chances for misadjustment and malfunction, to a minimum. RCA has designed a single servo stylus "arm stretcher" arrangement that consists of a small electromechanical transducer similar to the moving coil in a speaker that continuously drives the stylus arm back and forth along its long dimension according to the variations.

The arm stretcher is housed in a cage driven by a toothed belt to follow the basic groove spiral pitch of the disc. The entire arm sweeps across the disc's surface in a manner similar to that used by Teldec. RCA says that this combination of a belt-driven arm cage and the mechanically tracking stylus, guided by the actual groove spiral, preclude the necessity of holding to difficult mechanical manufacturing tolerances. The player has a built-in one-line horizontal delay for substitution of a preceding picture when a noise or similar defect occurs in an upcoming picture line.

Teldec and P/M have chosen an 1800-rpm playback speed that

equates to one frame every 360° of disc rotation, making it potentially easy to use the disc for still/slow/single-frame viewing. RCA's choice of 450 rpm, equating to four frames per 360° revolution (one frame every 90°), while not precluding these framing effects, makes providing for such features more complex and expensive. The company says that its choice of a 90° frame is critical to greater utility.

RCA is able to design an overall system that can currently offer a combination of the longest playing time with high picture quality. A two-sided disc that will give up to a 60-minute per disc program playing time will be offered with the RCA system.

The slower speed of the RCA player contributes to its ability to offer a less expensive system. The use of a simple stylus arm stretcher is also said to be less expensive than the means adopted by P/M to stabilize signal timing. RCA's lower-speed player enables its more complex stylus assembly to handle the expected amount of disc unbalance, eccentricity, and warp during playback.

While not yet committed to a market entry date, RCA says it could begin to provide players and discs in small retail quantities in the third or fourth quarter of 1976. Prices for the player and individual disc have been tentatively set at \$400 and \$10, respectively. The disc will give some 100 (minimum) plays in normal use, and the operating life of the stylus will be a minimum of 200 hours. A user-replaceable stylus/cartridge assembly is expected to sell for less than \$10. The player's modulated r-f output is set to an unused channel of any TV receiver, and separate outputs to drive a stereo system will be provided.

**Conclusion.** In this article, we have placed the emphasis on three systems that are almost certain to be available by the end of 1976. However, a host of other systems are under development. These include magnetic card (Sony) and magnetic disc (Bogen) systems that can record and erase and an optical disc system (i/o Metrics) that can record but not erase.

One thing is certain: separately or together, these home video systems will herald a new era in home entertainment. The prices will be right. And if all goes as expected, the programming will be on a par with the best live and film entertainment available anywhere today.



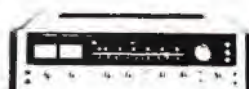
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# A New Industry Standard for FM Tuner Measurement

## PART ONE

BY LEN FELDMAN

**A**FTER an undisturbed 16-year reign, the old "IHFM Standard Methods of Measurement for Tuners" (IHFM-T-100) has been succeeded by the new "Standard Methods of Testing Frequency Modulation Broadcast Receivers." This new Standard (IHF-T-200 and IEEE Std 185-1975), was produced under the auspices of the IEEE, the IHF, and the EIA. It focuses on some key areas of tuner performance—including stereo—that were inadequately covered by the old Standard. (The old one was developed before stereo FM programming was authorized.) Also, it establishes new reference levels for sensitivity, selectivity, and distortion measurements, among others.

Hopefully, this new set of guidelines will enable manufacturers to relate their products' performances more meaningfully, and allow the consumer to make a well-informed decision when he goes to the marketplace.

**The Femtowatt.** One of the Standard's more important provisions deals with the basic reference level of signal strength. Previously, the microvolt ( $10^{-6}$  V) was used, but now the femtowatt ( $10^{-15}$  W) supplants it. Thus, instead of considering the amount of signal voltage developed across the tuner's antenna input, many

measurements will be based on the amount of power delivered to the tuner. By definition, an available signal power level of one femtowatt is the reference 0 dBf—not to be confused with its cousin, dB, which expresses something completely different.

But why power? The previous standard was ambiguous about the true amount of signal delivered to the

strength is the amount of power that's available, which is related to the voltage by the equation  $P = E^2/R$ . For example, 10  $\mu$ V across a 300-ohm input develops  $333 \times 10^{-15}$  W, but the same voltage across 75 ohms produces  $1333 \times 10^{-15}$  W—an increase of about 4 times, or 6 dB! Some manufacturers might quote the 75-ohm figure, which would apparently give them hotter receivers than those whose sensitivity was rated at 300 ohms. Now that everyone is expected to use the new power rating, specification differences based on type of termination will no longer be exaggerated.

Naturally, it will take time for people to get used to the dBf idea, so the IHF suggests that manufacturers publish the "new" figures alongside the old microvolt ones. This should make the transition smoother. The relationship between available power in dBf and open-circuit voltage across a 300-ohm impedance is shown in the nomograph of Fig. 1. Here we see that 0 dBf is equivalent to 1.1 "open-circuit"  $\mu$ V. Since the units increase exponentially, we'll now be reading sensitivity ratings such as 5 dBf or 1.96  $\mu$ V.

Signal generators that are used in FM tuner measurements usually have an output impedance of 50 ohms (unbalanced). To match this to the common 75- or 300-ohm balanced or un-

**Copies** of the new "Standard Methods of Testing Frequency Modulation Broadcast Receivers," IEEE Std 185-1975 and IHF-T-200, 1975, are available from the Institute of High Fidelity, 489 Fifth Ave., New York, NY 10017 and from the Institute of Electrical and Electronics Engineers, 345 E. 45th St., New York, NY 10017. 35 pages (8½" x 11), \$6.00 soft cover.

tuner. For example, most signal sources can deliver a higher voltage across an open circuit than across a resistive one, so "open-circuit" microvolts would produce a different result than "terminated" microvolts. Furthermore, tuner inputs are commonly either 75 or 300 ohms, and a standard based on voltage led to a 6-dB hedge due to loading effects.

What really determines signal



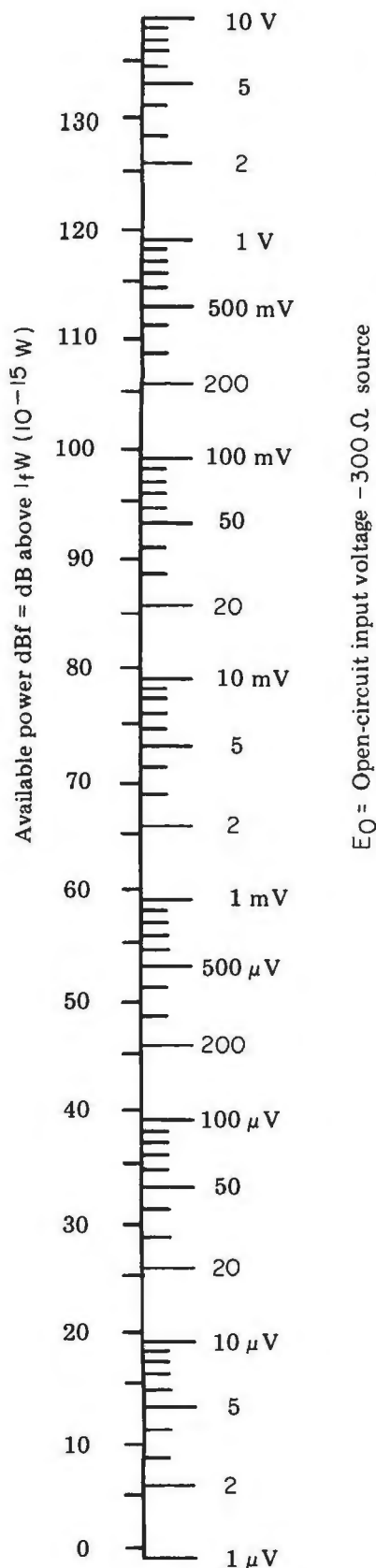


Fig. 1. Voltage/power nomograph relates available power in dBf (left scale) to open-circuit microvolts (right scale).

balanced tuner inputs, the Standard suggests eight dummy antenna configurations (Fig. 2). For each network,  $E_G$  is the terminated generator output voltage, usually indicated on a calibrated attenuator. (This works out to be half the open-circuit generator output voltage.) The open-circuit voltage at the receiver input terminals is designated as  $E_O$ . Power available to the receiver is  $P_A$ , and the power loss incurred by the dummy antenna (in dB) is  $P_L$ . Equations relating these variables are given in each case.

For example, suppose we're measuring the sensitivity of a tuner using the dummy antenna in Fig. 2A. With the "old" IHF procedure, we reached the IHF sensitivity when the generator's attenuator read  $4.0 \mu\text{V}$ . The reading would then be divided by 2, since half the voltage was "dropped" across the resistive network. Thus, the "old" IHF sensitivity would be  $2.0 \mu\text{V}$ .

In terms of the new Standard, the  $4.0 \mu\text{V}$  reading is  $E_O$ , the "open-circuit" voltage. Accordingly, no division is

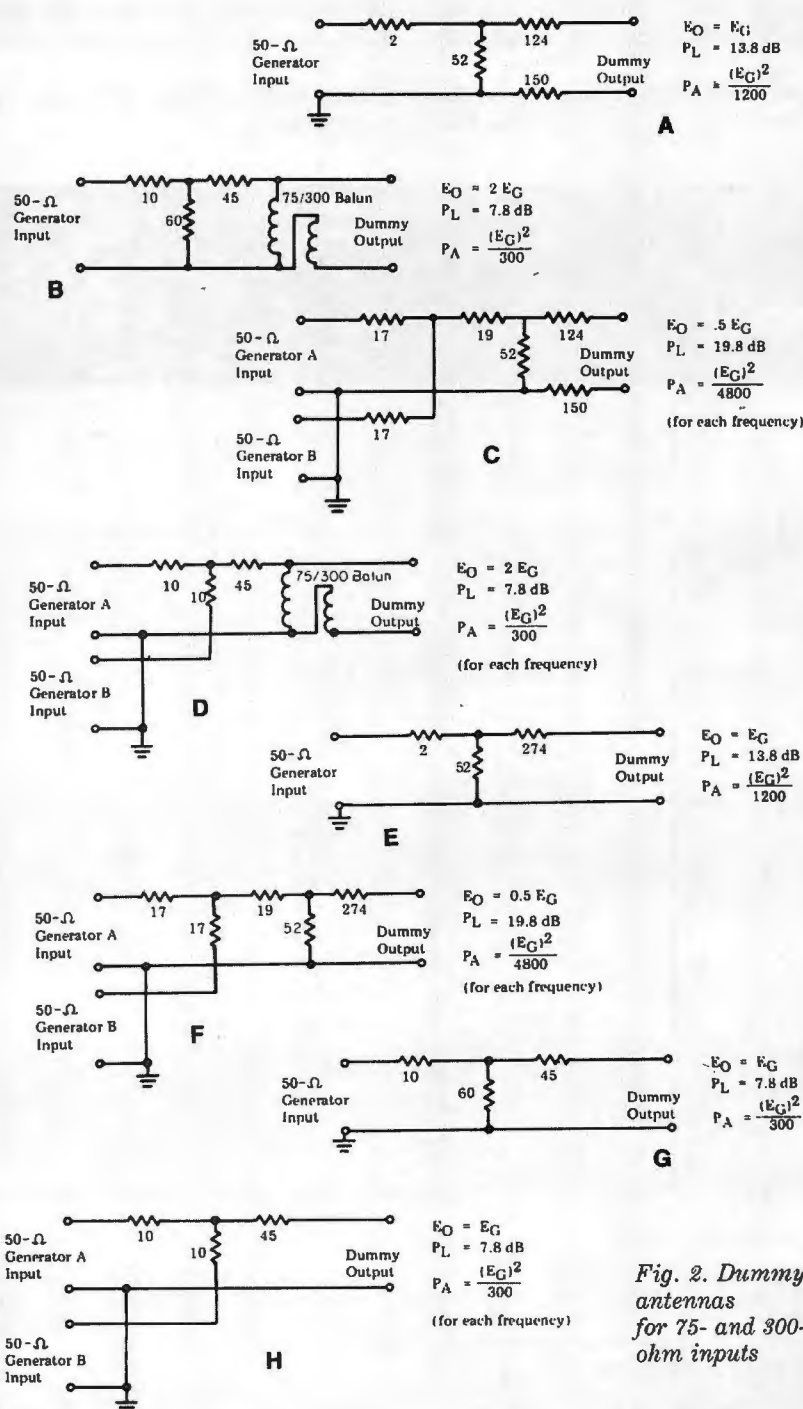


Fig. 2. Dummy antennas for 75- and 300-ohm inputs

required since  $E_o = E_G$  for this network. A glance at Fig. 1 shows us that the "new" sensitivity is about 11 dBf. If greater accuracy is desired, you can calculate the dBf figure using the formula:  $\text{dBf} = 20 \log (E_o/1.1)$ , where  $E_o$  is expressed in  $\mu\text{V}$ . For this particular case,  $E_o$  is  $4.0 \mu\text{V}$ , so the sensitivity in dBf is  $20 \log (4.0/1.1)$  or 11.213 dBf. A chart of dBf values versus generator output in  $\mu\text{V}$  is shown as Table I, and includes conversion formulae.

**New Mono Specifications.** It has become obvious that IHF sensitivity alone does little to point out significant differences between two modern tuners or receivers. Of far greater im-

portance is the nature of the "quieting slope," and more specifically, the point where a S/N ratio of 50 dB is obtained. For this reason, the new Standard requires disclosure of the "50-dB Quieting Sensitivity," expressed in dBf. The familiar "Usable Sensitivity" spec—the level of signal resulting in a combined noise and distortion content of 3% (–30 dB)—will also be included in dBf, because the public is familiar with it, and it takes into account both noise and distortion.

Although only residual noise is measured by the "50-dB Quieting Sensitivity" test (the modulating signal is turned off), it is of great interest

to determine how much harmonic distortion exists at this point. Therefore, a "Distortion at 50-dB Quieting" spec has been established. The distortion readings for this test and those at higher signal levels must be quoted for three frequencies—100, 1000, and 6000 Hz. Previously, THD was most often quoted at 1000 Hz, but it's well-known that most audio products exhibit lowest THD content in the mid-range. Hence, the additional measurements will give a more realistic picture of overall performance.

The Committees that collaborated on the Standard felt that 6000 Hz was the highest practical frequency to conduct this test. Harmonics of higher-frequency fundamentals are not only beyond the range of human hearing, but also extend past the upper limit of FM broadcast audio (15,000 Hz).

**Table I. Available Power From Dummy Antennas in Terms of Terminated 50 ohm Generator Output  $E_G$**

Impedance Dummy	300 ohms (B),(D)	300 ohms (A),(E)	300 ohms (C),(F)
Impedance Dummy	75 ohms (G),(H)		
dBf			
0	0.55 $\mu\text{V}$	1.1 $\mu\text{V}$	2.2 $\mu\text{V}$
5	0.97 $\mu\text{V}$	1.9 $\mu\text{V}$	3.9 $\mu\text{V}$
10	1.7 $\mu\text{V}$	3.5 $\mu\text{V}$	6.9 $\mu\text{V}$
15	3.1 $\mu\text{V}$	6.2 $\mu\text{V}$	12 $\mu\text{V}$
20	5.5 $\mu\text{V}$	11 $\mu\text{V}$	22 $\mu\text{V}$
25	9.7 $\mu\text{V}$	19 $\mu\text{V}$	39 $\mu\text{V}$
30	17 $\mu\text{V}$	35 $\mu\text{V}$	69 $\mu\text{V}$
35	31 $\mu\text{V}$	62 $\mu\text{V}$	120 $\mu\text{V}$
40	55 $\mu\text{V}$	110 $\mu\text{V}$	220 $\mu\text{V}$
45	97 $\mu\text{V}$	190 $\mu\text{V}$	390 $\mu\text{V}$
50	170 $\mu\text{V}$	350 $\mu\text{V}$	690 $\mu\text{V}$
55	310 $\mu\text{V}$	620 $\mu\text{V}$	1.2 mV
60	550 $\mu\text{V}$	1.1 mV	2.2 mV
65	970 $\mu\text{V}$	1.9 mV	3.9 mV
70	1.7 mV	3.5 mV	6.9 mV
75	3.1 mV	6.2 mV	12 mV
80	5.5 mV	11 mV	22 mV
85	9.7 mV	19 mV	39 mV
90	17 mV	35 mV	69 mV
95	31 mV	62 mV	0.12 V
100	55 mV	0.11 V	0.22 V
105	97 mV	0.19 V	0.39 V
110	0.17 V	0.35 V	0.69 V
115	0.31 V	0.62 V	1.2 V
120	0.55 V	1.1 V	2.2 V

### Strong Signal Measurements.

Tests formerly conducted at high (1000 "terminated"  $\mu\text{V}$ ) signal levels, such as "Ultimate S/N," "Ultimate THD," and "Stereo Separation" will now be performed at 65 dBf. That's roughly 1,970 "open-circuit"  $\mu\text{V}$ , or 970 "old IHF" (300-ohm)  $\mu\text{V}$ —almost the same signal level previously used. Capture ratio is measured in much the same way as before, but the readings must be taken at signal levels of 45 dBf and 65 dBf. The poorer of the two figures must be published as the "rated" capture ratio in dB.

**Two Selectivity Specs.** "Alternate Channel Selectivity," which spells out the degree of interference from an FM station 400 kHz away from the desired one, will now be measured at 45 dBf (desired signal input), or about 97 "old IHF"  $\mu\text{V}$ .

Now, we have another selectivity spec that must also be published—"Adjacent Channel Selectivity." The "numbers" are not going to look too good, of course. Obviously, it's much tougher to suppress signals 200 kHz away than those 400 kHz removed—at least it is when you're trying to maintain sufficient bandwidth for low distortion and good phase linearity. But as the public gets used to seeing "Adjacent Channel" figures in the 20-to-30-dB range, this "embarrassment" should fade away. (This concludes Part One. Next month, we'll examine new methods of curve plotting, and look at the new Stereophonic Specifications.)

$E_o$  = open-circuit voltage

$$= \sqrt{4 \times 10^{-15} R \times 10^{\text{dBf}/10}}$$

R = impedance level

dBf = available power for a 1 fW reference level

$$= 10 \log (E_o^2/4R \times 10^{-15}).$$

Note: Letters in parentheses refer to dummy antenna configurations shown in Fig. 2.



# THE OSCILLOSCOPE GRAPHIC ARTIST

BY MITCHELL WAITE



*Create exciting,  
computer-generated,  
three-dimensional  
drawings  
on your  
oscilloscope*

**A** DIM light traces a delicate pattern of geometrical lines on the screen of an oscilloscope. The lines form a rectangle that suddenly tilts back and transforms into a revolving ring of diamonds. You can produce these, plus many more, effects by operating the controls on the Graphic Artist project described here. You can easily make an image rotate in three dimensions, compress and expand, break up into other shapes, or slowly oscillate.

The Graphic Artist is a visual pattern generator that is designed to use the CRT screen of an oscilloscope as a "canvas" and its electron beam as a high-speed "brush." The real-time three-dimensional display on the CRT screen has all the delicate geometric beauty and detail of the computer-generated three-dimensional drawings with which we are all familiar.

The beam in an oscilloscope is forced to follow two complex, harmonically related signals in producing

the geometric patterns. Phase-shift networks, working in concert with a simple modulator, in the Graphic Artist add a signal that produces a depth and volume cue for the scope image.

If you're into electronic music, you might try feeding the output signal of the Graphic Artist into a stereo amplifying system to hear the tones associated with the on-screen images. Even more interesting, you can feed harmonics from a music source into the Artist's circuit in place of the oscillator signals. This allows you to view the patterns created by harmonically related musical notes.

**About the Circuit.** As shown in the block diagram in Fig. 1, two almost identical signal channels in the Artist are connected to the vertical and horizontal inputs of an oscilloscope. This hookup results in a CRT trace that is known as a Lissajous figure—a

circular-like trace that is proportional to the vertical and horizontal displacement of the scope's electron beam.

Each channel in the Artist consists of two oscillators (A and D) that generate square and triangular waveforms. Added to the signals produced by

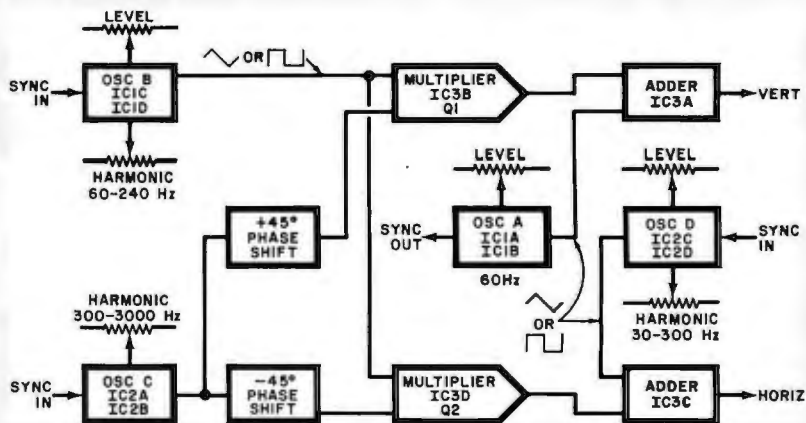


Fig. 1. Block diagram of Graphic Artist.

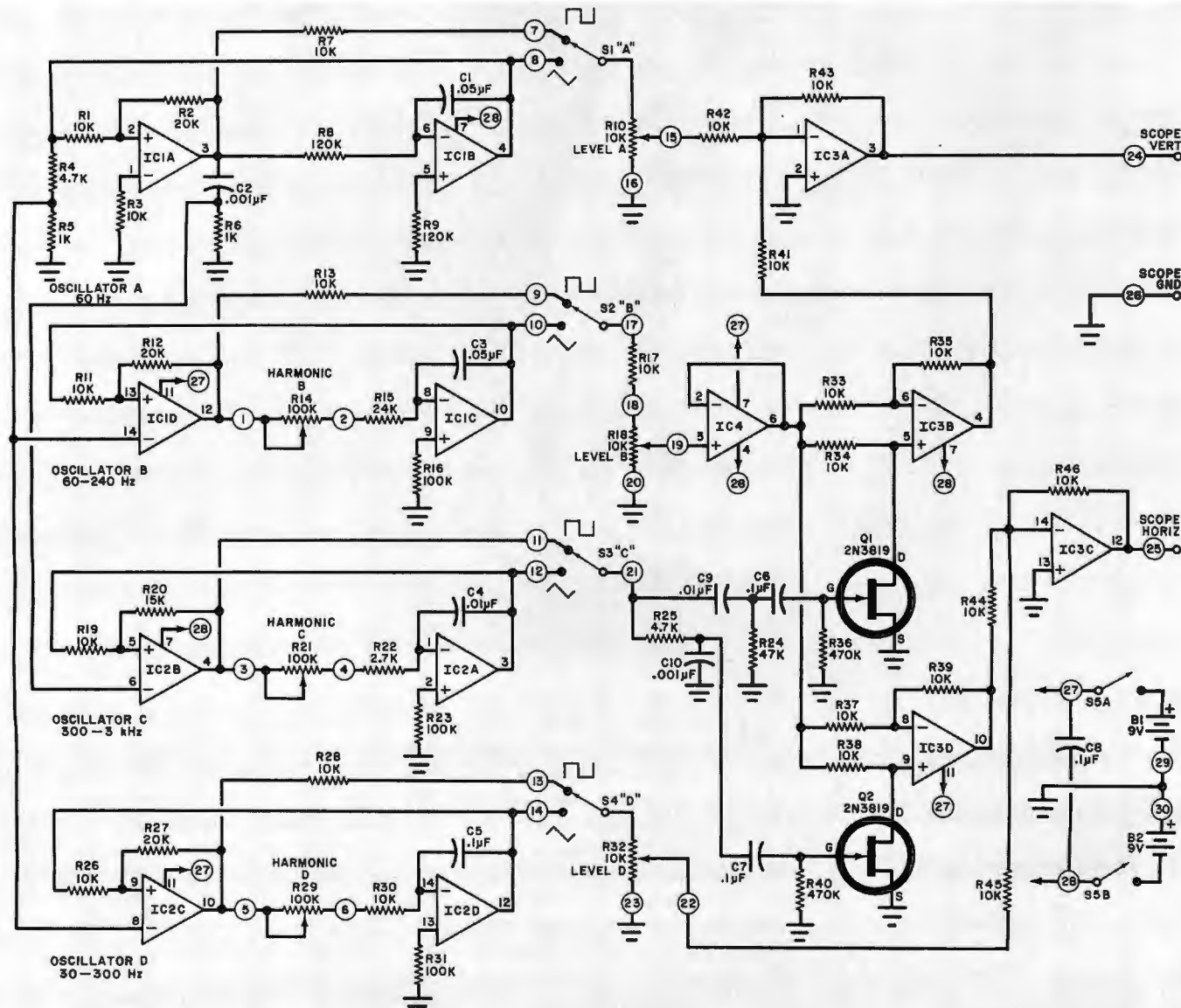


Fig. 2. Oscillators are identical except for frequency-determining elements.



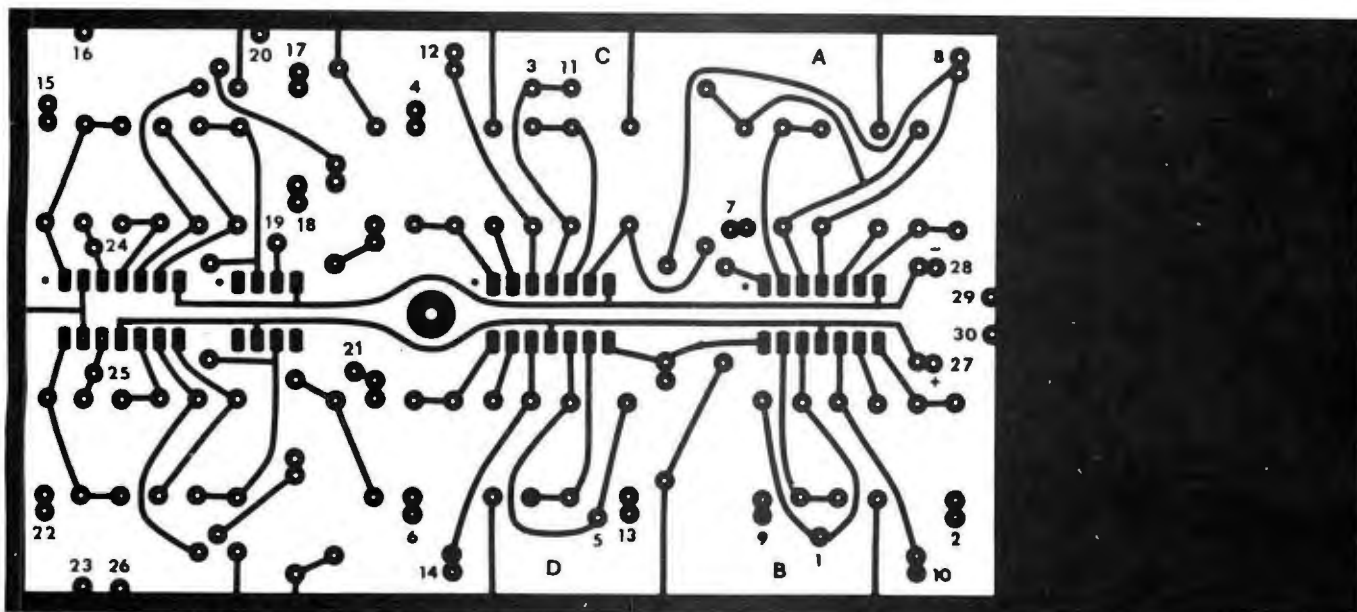


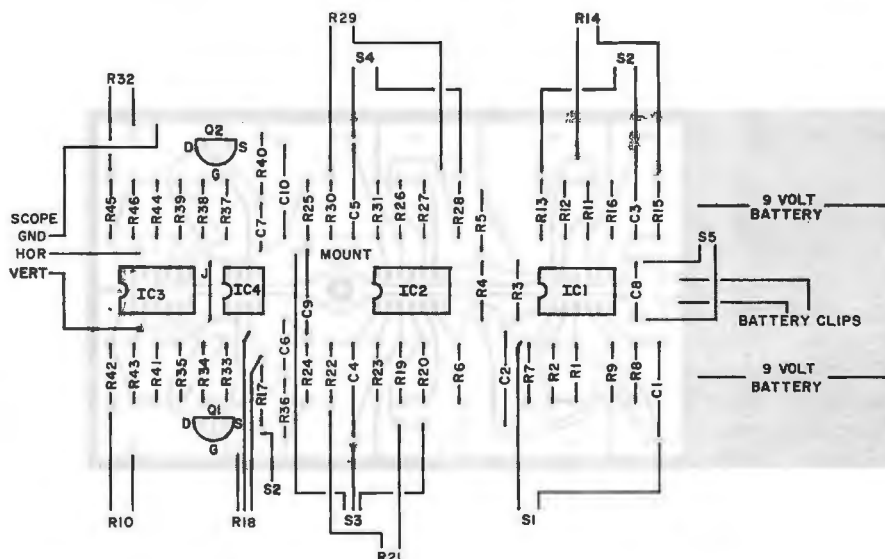
Fig. 3. Etching and drilling (above) and component (right) guides.

### PARTS LIST

- B1,B2—9-volt battery  
 C1,C3—0.05- $\mu$ F Mylar capacitor  
 C2,C10—0.001- $\mu$ F Mylar capacitor  
 C4,C9—0.01- $\mu$ F Mylar capacitor  
 C5,C6,C7,C8—0.1- $\mu$ F 100-volt Mylar capacitor  
 IC1, IC2, IC3—Quad 741 operational amplifier integrated circuit (Raytheon RC4136DB)  
 IC4—741 operational amplifier integrated circuit  
 J1, J2, J3—Five-way binding post  
 Q1,Q2—2N3819 junction field-effect transistor

The following resistors are 1/4-watt 10% tolerance:  
 R1,R3,R7,R11,R13,R17,R19,R26,R28, R30,R33,R34,R35,R37,R38,R39,R41, R42,R43,R44,R45,R46—10,000 ohms  
 R2,R12,R27—20,000 ohms  
 R4,R25—4700 ohms  
 R5,R6—1000 ohms  
 R8,R9—120,000 ohms  
 R15—24,000 ohms  
 R16,R23,R31—100,000 ohms  
 R20—15,000 ohms  
 R22—2700 ohms  
 R24—47,000 ohms  
 R36,R40—470,000 ohms  
 R10,R18,R32—10,000-ohm linear taper potentiometer  
 R14,R21,R29—100,000-ohm linear-taper potentiometer  
 S1 thru S4—Spdt slide or toggle switch  
 S5—Dpdt slide or toggle switch  
 Misc.—Printed circuit or perforated board; 7 1/2" L  $\times$  4 1/4" W  $\times$  2" D (19  $\times$  11  $\times$  5.1 cm) case; knobs (6); battery clips (2); lettering kit; hookup wire; machine hardware; solder; etc.

Note: The following are available from CalKit, P.O. Box 38, San Rafael, CA 94901: Complete kit #GA-1 (includes components, board, case, but not battery) at \$55; p.c. board #GA-3 at \$7.50. All orders postpaid. California residents, add 6% sales tax.



these oscillators is a common modulated signal derived from oscillators B and C. The overall shape of the Lissajous pattern is set by the signals from oscillators A and D. (For example, a simple rectangle results when triangular waveforms make up these signals.)

The modulation component is comprised of a variable high-frequency carrier from oscillator C and a variable medium-frequency envelope from oscillator B. The carrier is shifted in phase by  $\pm 45^\circ$ . The  $+45^\circ$  component is modulated by waveform B in the multiplier and summed with the waveform from oscillator A in an adder. Likewise, the  $-45^\circ$  carrier is modulated by waveform B but is summed with the waveform from oscillator D. When the phase-shifted components interact in the scope, they form another Lissajous pattern that is perpendicular to the major rectangle

pattern, creating the three-dimensional illusion of volume.

Each oscillator can be switched to generate square waves. Depending on which oscillator is switched to square waves, the pattern will either break up into multiple images or change the character of its surface composition. There are three level controls, which tilt or expand the image and change the relative sizes of the modulating components. The harmonic controls are frequency setting potentiometers that are used to adjust the ratio between the various harmonic signals. The ratios of the signals in turn control the "family" of images you see.

To prevent the patterns from revolving on the screen (this occurs whenever the patterns are derived from uncorrelated oscillators), one of the four oscillators is fixed in frequency. The output from this "master" oscillator is used to synchronize

the remaining oscillators, forcing them to run at an exact multiple of the syncing frequency.

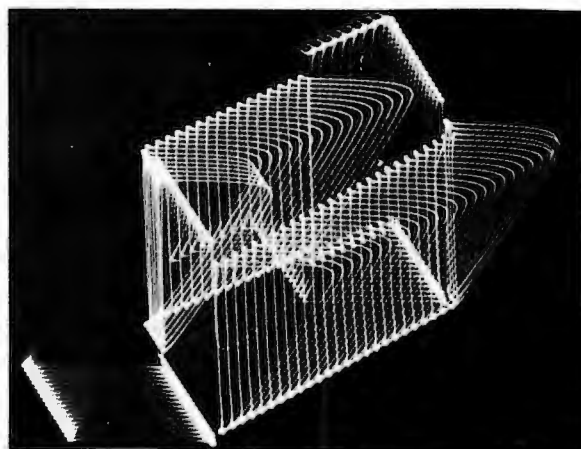
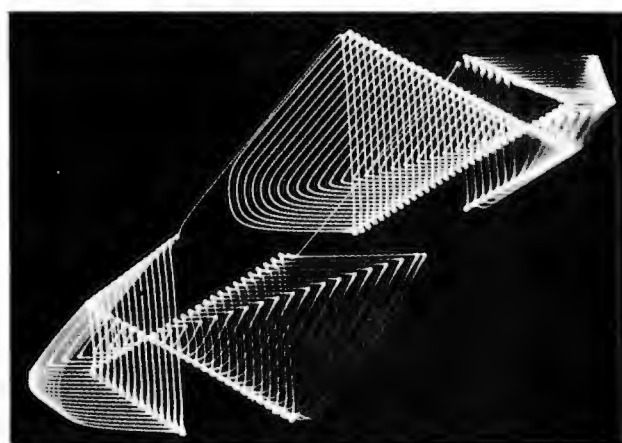
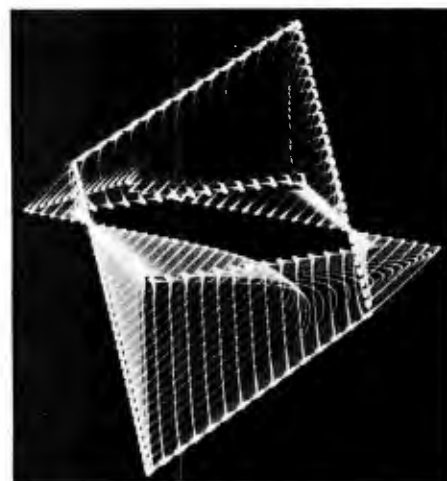
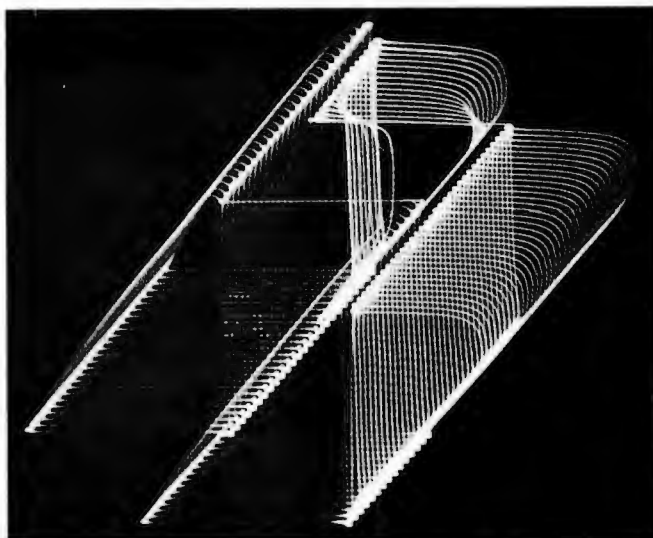
In addition to using the controls on the project, you can also use the vertical- and horizontal-gain controls on the scope to adjust the width and height of the images.

**Circuit Details.** As shown in Fig. 2, the four oscillators are identical except for their frequency-determining elements. Oscillator A is fixed at approximately 60 Hz by  $R8$  and  $C1$ ; oscillator B is variable from 60 to 240 Hz; oscillator C is variable from 300 to 3000 Hz; and oscillator D is variable from 30 to 300 Hz. The oscillators are arranged in a classical comparator-integrator configuration.

Taking oscillator A as an example,  $IC1A$  uses  $R1$  and  $R2$  to set the trip point at about  $\pm V_{cc}/2$ . The output of this comparator connects to integrator  $IC1B$ , which in turn, connects back to  $IC1A$ 's input. When  $IC1A$ 's output is at  $-9$  volts,  $IC1B$  linearly charges  $C1$  through  $R8$ . Hence, the output of  $IC1B$  is a positive-going ramp. As soon as the ramp reaches  $V_{cc}/2$ ,  $IC1A$  changes to the positive state and  $IC1B$  linearly discharges  $C1$  to initiate a negative-going ramp. When this ramp reaches  $-V_{cc}/2$ ,  $IC1A$  trips to the negative state and the cycle repeats itself.

Potentiometers are used to set the frequencies in the three variable-frequency oscillators by varying the charging currents. The outputs from the comparators ( $IC1D$ ,  $IC2B$ , and  $IC2C$ ) are symmetrical square waves, while the outputs from the integrators ( $IC1C$ ,  $IC2A$ , and  $IC2D$ ) are triangle waves. Resistor  $R10$  in fixed-frequency oscillator  $IC1A/IC1B$  sets the amplitude of the two waveforms. Level controls are provided for all but oscillator C. Oscillator C has no level control because only one signal need be variable if both signals go to the inputs of a multiplier to cause the output of the multiplier to vary.

The square-wave output from oscillator A is differentiated by  $C2$  and  $R6$  to create a sync pulse. This pulse is fed to the inverting ( $-$ ) input of  $IC2B$  to force oscillator C's operating frequency to be an exact multiple of the operating frequency of oscillator A. To sync the remaining oscillators, the triangle-wave output from oscillator A is attenuated by  $R4$  and  $R5$  and fed to the inverting inputs of  $IC1D$  in oscillator B and  $IC2C$  in oscillator D. The 60-Hz



*Photos illustrate only five of the countless varieties of waveform displays possible.*



triangle wave forces oscillators B and D into exact sync. Resistor *R7* in oscillator A makes the square and triangle waves in this oscillator equal in amplitude. Switches *S1* through *S4* provide means for selecting the desired waveforms.

Integrated circuit *IC4* is an op amp follower, used here to reduce the source impedance to chopper-type multipliers *IC3B* and *IC3D*. In this type of multiplier, a bipolar transistor or JFET is used to switch the op amp between a noninverting (+) and an inverting (-) unity-gain buffer. Transistor *Q1* serves this purpose in this circuit.

When the signal in oscillator C goes positive, *Q1* conducts and *IC3B* reverts to an inverting amplifier. When oscillator C goes negative, *Q1* starts to cut off, and *IC3B* becomes a noninverting amplifier with unity gain. This switching action results in suppression of the carrier, and the output of *IC3B* is a balanced four-quadrant signal.

The signal from oscillator C is shifted in-phase by +45° in network *C9-R24* and by -45° by network

*C10-R25*. So, the waveform to each JFET (*Q1* and *Q2*) is out-of-phase, resulting in a modulated output from the multiplier also being out-of-phase. Networks *C6-R36* and *C7-R40* provide dc restoration for *Q1* and *Q2*.

The output from multiplier *IC3B* is summed with the signal from oscillator A in adder *IC3A*. The output from multiplier *IC3D* is summed with the signal from oscillator D in adder *IC3C*. Finally, the outputs from the two adders are fed to the oscilloscope to form the complex Lissajous patterns.

Power is supplied to the Artist by two standard 9-volt batteries (*B1* and *B2*). Capacitor *C8* aids in reducing instability in the IC op amps.

**Construction.** The project can be built on either printed circuit or perforated board. The actual-size etching and drilling guide and components-placement diagram are shown in Fig. 3. After preparing or buying a ready-to-use pc board (see Parts List for supplier), mount the components on it as shown in the placement diagram, paying particular attention to the orientations of the IC's and transistors. Place *B1* and *B2* on the blank end of the board, terminals pointing away from the components, and fasten them in place with loops of wire passed between the batteries. Temporarily set aside the board assembly.

Next, machine the front panel for the six potentiometers, five switches, three binding posts, and a No. 6 machine screw. The last hole should line up exactly with the large hole in the pc board assembly. Mount the pots, switches, and binding posts in their respective locations (see Fig. 4). Pass a 6-32 x 2" machine screw (to support the circuit board assembly) through the remaining hole, slip over its threads a length of plastic spacer, and follow with a No. 6 machine nut. The spacer should be just long enough that, when the nut is in place, about 1/4" of screw thread is still visible. Label the controls, switches, and binding posts.

Referring back to Fig. 2 and Fig. 3, finish wiring the project.

**Operation.** The oscilloscope used with the Graphic Artist must have an external horizontal input. Connect test-lead cables from the output binding posts on the Artist to the appropriate inputs on the scope. Set all waveform switches to triangle. Switch on the project and scope.

Set time LEVEL B control fully counterclockwise (off). Because oscillator B connects to both multipliers, making LEVEL B zero eliminates the modulated component on the screen. You should now see a simple rectangular or square Lissajous pattern. Adjust the horizontal- and vertical-gain controls on the scope so that, when LEVEL A and LEVEL D controls are set to midrange, the image just fills most of the screen.

Slowly turn up LEVEL B. This adds the modulated waveform to the existing pattern. Readjust LEVEL A and LEVEL D for a pleasant balance and to keep the image from drifting off-screen. Adjust HARMONIC B to sync the modulated envelope with the image. In essence, this control sets the number of "lobes" riding on the primary Lissajous pattern.

Next, adjust HARMONIC C so that the high-frequency carrier is in sync with the image. You should now have a display similar to those shown in the photos. The next thing we can do is alter the Lissajous "family" by using combinations of the waveform switches. For example, switching WAVEFORM A to the square-wave position and setting WAVEFORM D to the triangle-wave position causes the image to break up into separate shapes. There are 16 combinations for the four waveform switches. Add to this the effects of the six HARMONIC and LEVEL controls, and chances are you will never see the same pattern twice.

After you've familiarized yourself with the operation of the controls (it does take some skill), you might try connecting a pair of stereo headphones to the two output channels. The sounds of the four oscillators mixing and adding produces beat notes that are fascinating in themselves. You can even "play" the sounds by twisting the various controls.

Some very different and interesting effects can be produced by running the Graphic Artist in reverse. Take a signal from an external source, such as an electronic organ, and connect it in place of one of the oscillators. You can do this by disconnecting one waveform switch input and connecting your signal in its place. Choose your notes to be exact even or odd harmonics of oscillator A, which operates at approximately 60 Hz. The images will appear to stop their motion and their actual shape will depend on the particular waveform of the note being played.

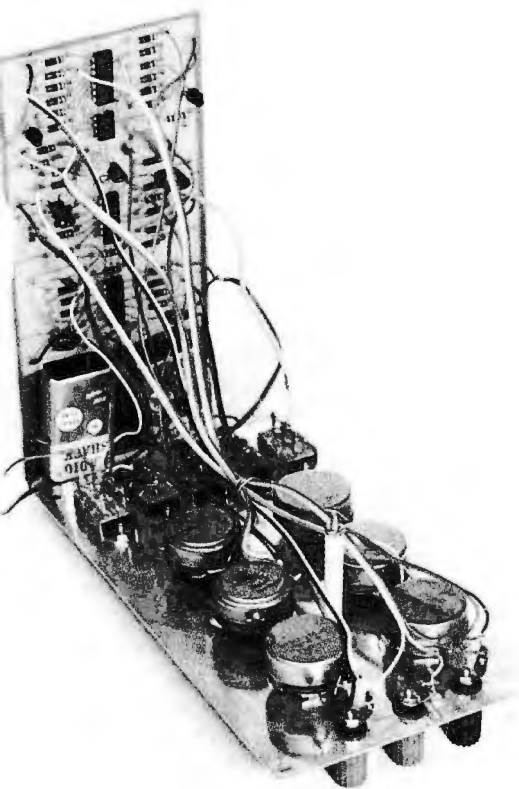


Fig. 4. Construction details.



# BUILD A PREREGULATED POWER SUPPLY

*Super-stable,  
multi-purpose supply for  
the experimenter's workbench*

**A**NYONE who works with modern electronic circuits, whether he is a professional or an amateur, will eventually require a closely regulated variable power supply. While most power supplies are regulated directly from the basic rectified and filtered dc line, tighter regulation can be obtained by using a preregulated approach in the supply's design.

The preregulated power supply described here can be built for about \$15 more than you would have to pay for a conventionally regulated low-current supply. It employs two inexpensive 723 voltage regulator IC's in a circuit that can deliver 3 to 35 volts dc at load currents up to 3 amperes. The design eliminates the need for massive heat sinks and cooling fans.

**How It Works.** The power supply's circuit shown in Fig. 1 can be functionally diagrammed as an ac source, rectifier bridge, and two voltage regulators in series. The preregulator, by means of SCR1, continuously controls the potential at C1 so that the potential across Q1 remains constant. The output regulator (IC2) is a high-performance circuit that is capable of providing 0.1% regulation.

Synchronized to the 120-Hz rectified ac input, preregulator integrated circuit IC1 is connected as a time-delayed pulse generator that controls the gate of SCR1 to trigger conduction at the exact point required during each half cycle. The bias voltage applied to the inverting input (pin 2) of

IC1 is adjustable via potentiometer R9; it determines the reference level for the supply.

The zener-regulated source at pin 4 of IC1 also supplies current through R14, R15, and R18 to C4 and pin 3 (noninverting input). The current continues to flow until the reference voltage is exceeded. At this point, IC1 turns on. The resulting square-wave pulse from pin 6 of the IC is limited to 9 volts by current-sensing resistors R12 and R13, which is sufficient, at the gate of SCR1, to trigger the SCR into conduction.

The RC time constants in the circuit are controlled by the amount of current flowing through Q3, which, in turn, depends on the error voltage present at the wiper of R10A. A voltage divider consisting of R16 and diodes D7 through D10 applies a relatively constant 2.4 volts to the emitter of Q3 so that when the transistor's base goes above 3 volts there will be a voltage drop across R14 and a corresponding change in the RC time constant. Capacitors C5 and C6 stabilize the operation of Q3 to prevent SCR1 from firing erratically. When R10 is rotated counterclockwise, R17 and D13 protect Q3 and D12 from damage.

The method of synchronizing IC1 to the rectified input is graphically shown in Fig. 2. Triggered into conduction by the positive-going voltage, SCR1 cuts off when the gate signal ceases and C4 discharges sufficiently to reduce to a minimum the holding current to the SCR. The diagram also

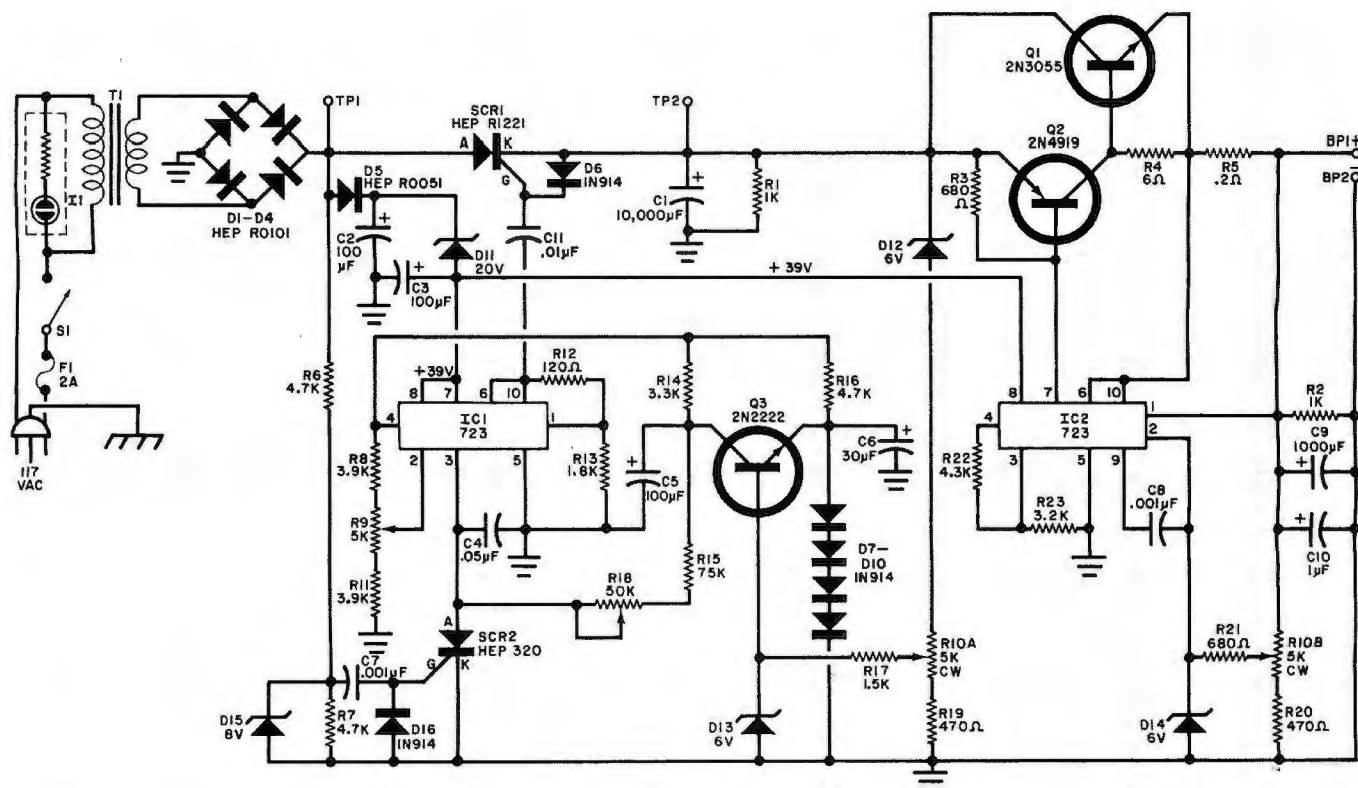
reveals why the secondary voltage from T1 must be greater than would be normal in a conventionally regulated power supply. The SCR cannot conduct until its anode is more positive than its cathode. Simultaneously, a minimum latching current must flow. Also, SCR1 must remain conducting until the energy drawn from C1 by the output load is replaced.

Since the potential across C1 will be 41 volts at maximum output, the 18-volt difference allows the time interval necessary for maximum current. This also means that SCR1 fires only near the peak or on the negative-going side of the waveform. Resistors R1 and R2 are bleeders that carry the minimum holding current required by SCR1.

Dual potentiometer R10 establishes feedback to both voltage-regulator IC's. (A wire-wound potentiometer is best used here so that the sections will be more evenly matched. So, if an identical voltage were present across each section of the pot, the wiper voltages would be very nearly the same at any setting.) Potentiometer section R10B samples the output voltage and drives IC2 in the proper direction to maintain 3 volts between wiper and ground. The A section of the pot samples the voltage across C1 and controls the firing of SCR1, also maintaining 3 volts between wiper and ground.

Since the potential at the counterclockwise ends of R10A and R10B must be the same, the potential across





BP1, BP2—Five-way binding post (one black, one red)  
 C1—10,000- $\mu$ F, 50-volt electrolytic capacitor  
 C2, C3—100- $\mu$ F, 65-volt electrolytic capacitor  
 C4—0.05- $\mu$ F disc capacitor  
 C5—100- $\mu$ F, 10-volt electrolytic capacitor  
 C6—30- $\mu$ F, 10-volt electrolytic capacitor  
 C7, C8—0.001- $\mu$ F disc capacitor  
 C9—1000- $\mu$ F, 50-volt electrolytic capacitor  
 C10—1- $\mu$ F, 50-volt tantalum electrolytic capacitor  
 C11—0.01- $\mu$ F disc capacitor  
 D1 thru D4—100-PIV, 3-ampere rectifier (Motorola HEP R0101 or similar)  
 D5—100-PIV, 1-ampere rectifier (Motorola HEP R0051 or similar)  
 D6, D7 thru D10, D16—IN914 diode  
 D11—20-volt, 1-watt zener diode (Motorola HEP Z0421 or similar)

## PARTS LIST

D12—6-volt zener diode (1N429 or similar)  
 D13, D14—6-volt zener diode (1N1509 or similar)  
 D15—8-volt zener diode (Motorola HEP Z0217 or similar)  
 F1—2-ampere slow-blow fuse  
 I1—Neon panel lamp with resistor  
 IC1, IC2—723 voltage regulator integrated circuit (in TO-5 can)  
 Q1—HEP 704 (Motorola) or 2N3055 transistor  
 Q2—HEP 246 (Motorola) or 2N4919 transistor  
 Q3—HEP 736 (Motorola) or 2N2222 transistor  
 R1, R2—1000-ohm, 2-watt, 10% resistor  
 R3, R21—680-ohm, 1/2-watt, 5% resistor  
 R4—6-ohm, 1-watt, 5% resistor  
 R5—0.2-ohm, 2-watt, 5% resistor  
 R6—4700-ohm, 1-watt, 5% resistor

R7, R16—4700-ohm, 1/2-watt, 5% resistor  
 R8, R11—3900-ohm, 1/4-watt, 5% resistor  
 R9—5000-ohm miniature pc potentiometer  
 R10—5000-ohm dual wire-wound potentiometer  
 R12—120-ohm, 1/4-watt, 5% resistor  
 R13—1800-ohm, 1/4-watt, 5% resistor  
 R14—3300-ohm, 1/4-watt, 5% resistor  
 R15—75,000-ohm, 1/4-watt, 5% resistor  
 R17—1500-ohm, 1/4-watt, 5% resistor  
 R18—50,000-ohm, miniature pc potentiometer  
 R19, R20—470-ohm, 1/2-watt, 5% resistor  
 R22—4300-ohm, 1% resistor  
 R23—3200-ohm, 1% resistor  
 SCR1—HEPR 1221  
 SCR2—HEP 320  
 S1—Spst switch  
 T1—Transformer, 42V, 3A Secondary  
 Misc.—Printed circuit or perforated board; suitable cabinet; heat sink; fuse holder; sockets for IC's (2); etc.

Fig. 1. Power supply employs two voltage-regulator IC's for super stability.

C1 will be 6 volts greater than the output because of the action of D12. Any change in the output voltage and/or current will affect the firing-pulse timing at the gate of SCR1, maintaining a constant potential across Q1.

**Construction.** The easiest way to assemble the power supply is by using a printed circuit board. (See Fig. 3 for actual-size etching and drilling and component placement guides.) Alternatively, you can assemble the circuit on perforated board using solder clips and sockets. Whichever method you use, refer to the table in Fig. 3 for instructions on how to interconnect the circuit board assembly and the com-

## SEQUENCE OF EVENTS

- SCR2 fires as C7 charges; C4 then discharges and IC1 cuts off.
- D15 limits voltage on C7; SCR2 cuts off and C4 begins to charge.
- C4 has charged above reference level at pin 2 of IC1, causing the IC to conduct; a trigger pulse at pin 6 turns on SCR1 through C11.
- SCR1 current decreases as C1 voltage increases. When voltage across SCR1 is insufficient to maintain about 10 mA current, SCR1 turns off.

Note: SCR1 turns on and off at approximately C and D on the curve, when the output load is drawing 3 amperes at 35 volts. With no external load, events C and D occur near the end of the wave as indicated by the unmarked dots.

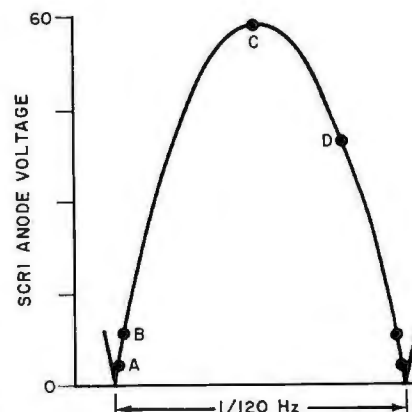


Fig. 2. Events above left are keyed to points on curve.

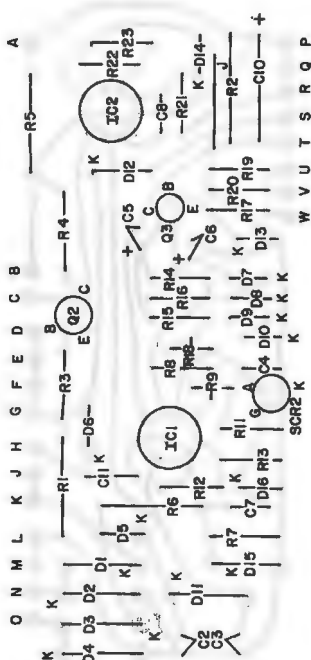
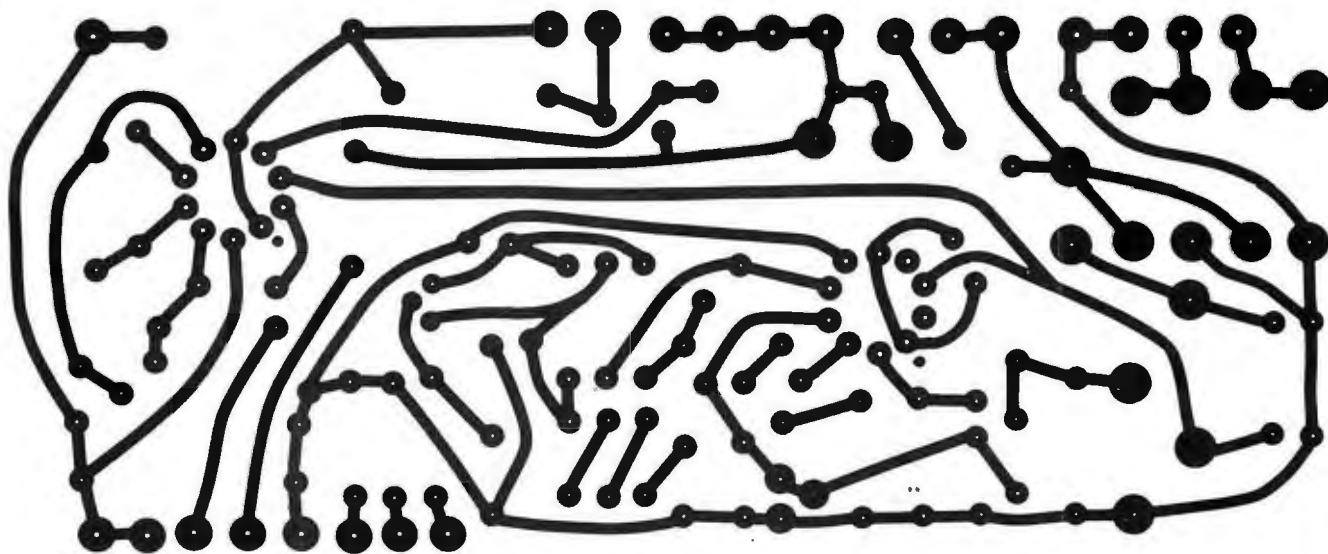


Fig. 3. Actual-size etching and drilling guide is shown above; component-placement diagram is at left; table at right details hookups between board and off-the-board components.

#### CONNECT

FROM:	TO:	FROM:	TO:
A	C9 +	M	C1 -
B	Q1 E	N, O	T1 S
C	Q1 B	P	BP1
D	Q1 C	Q	R10B CCW
E	TP2	R	R10B WIP
F	C1 +	S	R10A CCW
G	SCR1 K	T	BP2
H	SCR1 G	U	R10A CW
J	SCR1 A	V	R10B CW
K	TP1	W	R10A WIP
L	C9 -		

Mount the off-the-board components, followed by the circuit-board assembly inside the cabinet. Then refer to the table in Fig. 3 and Fig. 1 to complete wiring the system.

**Test and Use.** To balance out component tolerances, IC1 must be initially aligned. To accomplish this, you will need an oscilloscope, high-impedance multimeter, and an improvised load. Rotate R10 counterclockwise, set R18 to maximum resistance and R9 for maximum voltage gain at pin 2 of IC1 before applying power to the supply. Connect the scope from TP1 to ground and the multimeter from TP2 to ground. Turn on the power.

There should be a small voltage present at TP2, but the scope should indicate that SCR1 is not conducting. Keeping the voltage reference as high as possible at pin 2 of IC1, adjust R18 and R9 until SCR1 fires regularly and the meter indicates 9 volts at TP2. When R10 is rotated fully clockwise, the meter should indicate 41 volts at TP2.

Temporarily short out R5 and momentarily connect a 12-ohm,

120-watt resistor (or an equivalent combination) across the output via BP1 and BP2. If the TP2 reading drops more than 0.2 volt or SCR1 fires intermittently, adjust R9 only enough to correct. Then, with no load connected to the output of the supply, rotate R10 counterclockwise. The reading at TP2 should slowly decrease to 9 volts. If it does not, adjust R9 for a higher voltage at pin 2 of IC1 until it does.

Rotate R10 again and apply the load, compensating for the voltage drop by adjusting R18. There will be some combination of the two adjustments that will permit Q3 to retain control over IC1 throughout the specified voltage and current ranges. To do this, Q3 must always be forward biased. If at any time Q3 does not draw the proper current from R14, it has lost control.

Correct alignment will be achieved when the voltage at the wiper of R10A is the same at any output. As a further test, connect the meter across Q1 and note the voltage change when R10 is rotated clockwise. Any difference would correspond with D12's zener voltage characteristics at bias currents of from 1 to 7mA.

Note: Components shown from foil side of board.

ponents located off the printed circuit board.

Select a cabinet for the supply that is large enough to accommodate all components without crowding. Machine the front panel for potentiometer R10, lamp/resistor assembly I1, and binding posts BP1 and BP2. Mount the components in their respective holes.

Next, mount Q1 and SCR1 on a 4" x 2½" x 1" (10.2 x 6.4 x 2.5-cm) finned heat sink. Drill mounting holes for this assembly, the line cord, and fuse holder through the rear panel of the cabinet. Mount the fuse holder and heat-sink assembly in place. Line the remaining hole with a rubber grommet for the line cord.



# BUILD AN AUTOMOBILE LOGIC ALARM

*Simple circuit monitors five electrical points in the car and sounds an alarm when the wrong conditions occur.*

BY ROBERT GRATER

**M**ODERN cars have warning systems that monitor various conditions in the engine, lights, etc. One such system is the buzzer that sounds when the driver's door is opened with the key still in the ignition. There are other conditions that can also be monitored if you install the Logic Alarm described here. These include: leaving the headlights on when the ignition is turned off, leaving the ignition on when the oil pressure is low; and leaving the ignition on when the engine is overheated. (As options, the brake and seat-belt warning light circuits can be monitored.) An extra advantage of the Logic Alarm is that the raucous buzzing of most door warning systems can be replaced by a more pleasing audio tone.

**Circuit Operation.** As shown in Fig. 1, the Logic Alarm uses a single 74L86 low-power quad exclusive-OR gate that receives power from the car's

12-volt line (negative ground) regulated by a 5-volt zener diode. The IC has four separate gates, each producing an output if its two inputs are in opposite states. A gate will not deliver an output if both inputs are simultaneously high or low.

The 74L86 is used because it is a low-power device requiring only 3 mA. It is not a pin-for-pin replacement for the conventional TTL 7486, which requires more current. The 7486 could be used if the circuit is changed to suit the different pin arrangement, the value of  $R_9$  is changed because of greater current flow, and a switch is added to turn off the 12-volt supply when not needed.

The outputs of the four gates pass through diode isolators to a solid-state alarm (another low-power device).

For the headlights-on/ignition-off circuits, the inputs of gate A are held high by the supply through  $R_1$  and  $R_2$ .

With the headlights off,  $D_1$  and  $D_2$  conduct, maintaining the stable status of gate A. However, with the headlights on and the ignition off,  $D_3$  conducts and input 2 to the gate drops, providing an output from the gate.

The oil-pressure (gate B) and temperature (gate C) circuits are identical. One side of each gate is coupled to the ignition through  $D_4$  and  $D_6$ , respectively so that they are in a high state when the ignition is on. The oil-pressure and temperature sensing signals should also be high when the engine is running. Thus there are no outputs from these gates. When the vehicle is first entered and the ignition is turned on (prior to starting the engine), the oil-pressure and temperature sensors will be "cold," and the alarm will sound. This serves as a system test. (If the car has instrument-panel lamps for these functions, the Logic Alarm will provide a warning even if one of the lamps fails.)

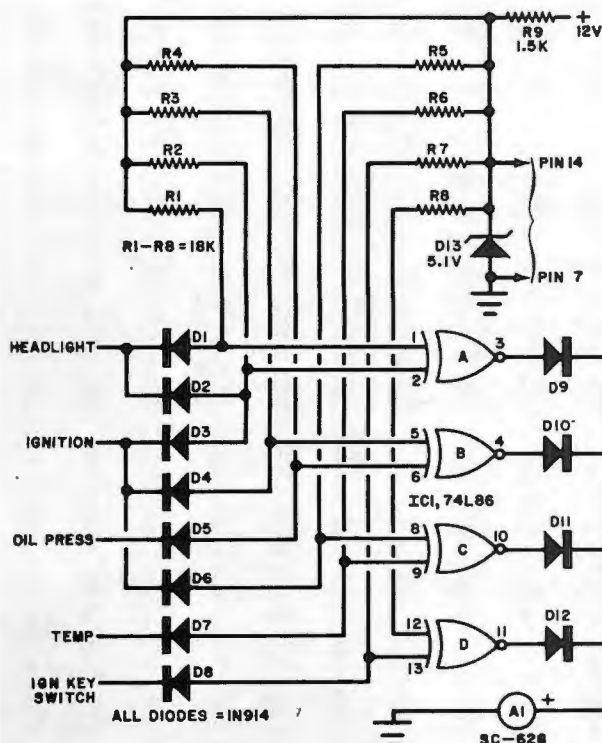


Fig. 1. Points to be monitored are connected to exclusive OR gates through diodes.

## PARTS LIST

- A1—Tone generator (Mallory Sonalert SC-628 or similar)
  - D1 to D12—Diode (1N914 or similar)
  - D13—5.1-V, 1/2-W zener diode (HEP ZO-212 or similar)
  - IC1—Quad exclusive OR gate (74L86)
  - R1 to R8—18,000-ohm, 1/4-W resistor
  - R9—1500-ohm, 1/4-W resistor
  - Misc.—14-pin DIP socket, pc or perforated board, wire for connections, mounting hardware, etc.
- Note: The following are available from RGS Electronics, 3650 Charles St., Suite K, Santa Clara, CA 95050: kit of parts including pc board but not Sonalert at \$6.35 including postage and handling; pc board alone at \$2.50.

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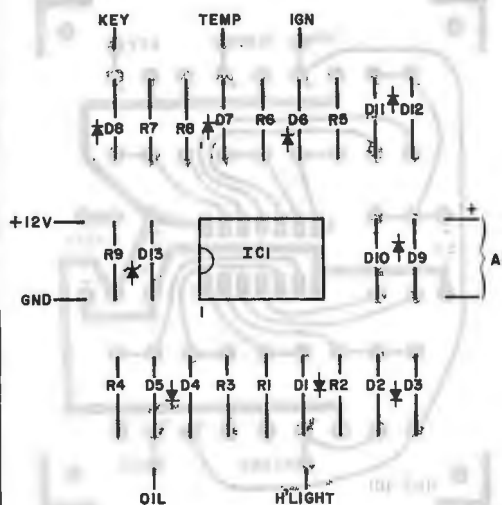
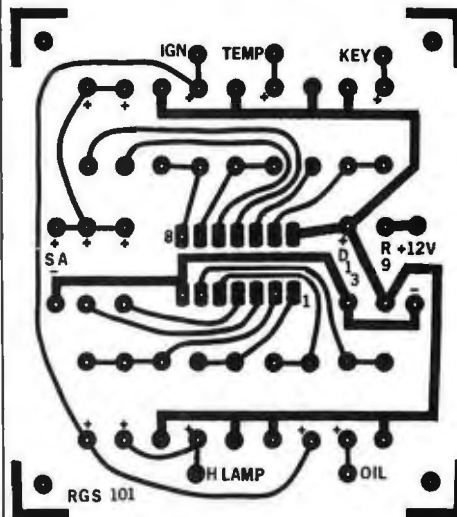


Fig. 2. Etching and drilling guide for pc board is shown below; component layout at left.



The "you left the key in the ignition" circuit uses gate D, with one input connected to the ignition switch through D8. Thus when the ignition key circuit goes to ground with the key in, one input is low, causing the alarm to sound.

**Construction.** The Logic Alarm can be assembled on a pc board (Fig. 2) or wired point-to-point on perforated board. The board assembly can be cemented directly to the back of the alarm. The alarm can then be mounted either in a hole cut in the dashboard or in a small enclosure mounted under the dashboard.

**Wiring.** The headlight sensing point can be picked up either at the fuseblock or the headlight switch—or on the headlight wire using an insulated connection. Use a dc voltmeter to make sure that this point is at 12 volts when the lights are on.

The best place to get at the ignition circuit is at the fuseblock. Use a dc voltmeter to locate a circuit that is at 12 volts when the ignition is on.

The +12 volts used to power the alarm can also be obtained from the fuseblock. The alarm can be wired permanently to the supply since the power consumption is so low. Using the fuseblock to pick off the various signals allows the application of conventional automotive snap-in connectors sold at most automotive supply stores.

The oil-pressure and temperature pickoff points can be made as shown in Fig. 3A, using an insulated connector.

The circuit from the ignition key must be located with the voltmeter and should be at 12 volts with the key in the switch. Fig. 3B shows the buzzer circuit used in most GM cars—others are similar. The buzzer is in the horn relay enclosure and ground is provided through the key switch and door switch. Remove the wire marked with an X in Fig. 3B and connect to it for the ignition key sensing.

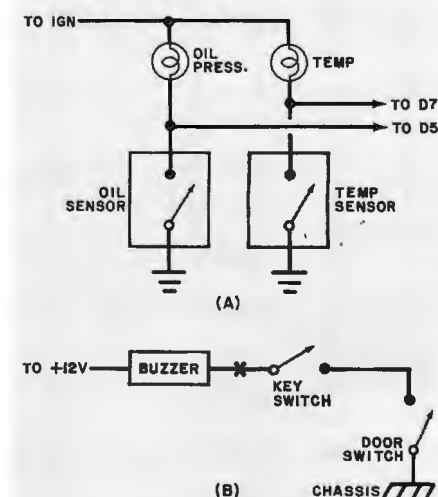


Fig. 3. Circuits for connecting to monitored points.



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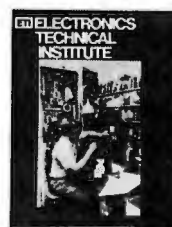
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# Product Test Reports

## ABOUT THIS MONTH'S HI-FI REPORTS

*International Audio Designs is an unfamiliar name in the hi-fi marketplace, but the company's Model B3A dynamic range expander should have a wide appeal for audiophiles who wish to restore some of the dynamics lost in their compressed tape and disc recordings and FM broadcasts. The expander can add up to 15 dB of dynamic range to the program. Its gain variations are absolutely undetectable while listening to a program.*

*When Shure Brothers announces a new phono cartridge, you can be sure that it is designed to fill a definite need in the marketplace. The Model M95ED has the flat, uncolored sound of the highly respected Shure V-15 Type III at a price most critical audiophiles can afford.*

*Yamaha, a company well-known for its motorcycles, has only recently had its audio products achieve a telling fame on the hi-fi scene. The company's Model CR-800 stereo receiver does almost everything you could require of a deluxe receiver. It performs more like the most refined separate components than like a compact, reasonably priced receiver.*

—Julian D. Hirsch

### IAD MODEL B3A DYNAMIC RANGE EXPANDER

*Restores dynamics to compressed recorded material.*



International Audio Designs has recently introduced a novel dynamic range

expander whose operating parameters (as we'll see) are radically different from those of other expanders we have used. The Model B3A, as with other expanders, is designed to restore some of the program dynamics that are inevitably lost in any compressor-processed recording or broadcast program.

The expander is housed in an attractive black plastic case with thick clear plastic end plates. The case measures 12"L x 5 1/4"D x 3 3/4"H (30.5 x 13.3 x 9.5 cm) and weighs 3 1/2 pounds (1.6 kg).

The manufacturer's warranty covers defects in material and labor for a period of three years from date of purchase. The retail price of the expander is \$279.

**Technical Details.** The designer of an expander must choose appropriate attack and release time constants, as well as the slope of the expansion (such as 1.5 dB of output change for 1 dB of input signal change). The goal is usually to restore some measure of the compressed dynamics of the program without introducing audible side effects. Almost all expander designs have fallen short of the latter requirement.

If the expansion is accompanied by

"pumping" sounds as the level changes or by transient "fuzz" or "swishes" of background noise, the expander is of little value to the user. By careful design and by limiting the degree of expansion to some extent, these effects can be minimized. It is difficult to eliminate them completely.

IAD has chosen an attack time of 100 ms for the Model B3A, which is relatively slow for some expanders but is fast enough to be effective. On the other hand, a very long release time on the order of 30 seconds renders the reduction in gain following an expansion completely inaudible. As we determined during our tests, the action of the IAD expander is somewhat more complex than this would indicate, but its extremely long release time certainly distinguishes the IAD approach from all others we have seen.

The expander provides a smoothly controllable expansion of as much as 15 dB or more. It can be inserted in the signal path between a preamplifier and a power amplifier or in the tape-monitoring system in an integrated amplifier. With no expansion, the gain of the expander is unity, with each channel's signal passing through an operational amplifier that uses some 80 dB of negative feedback. The input impedance is 47,000 ohms, while the output impedance is 600 ohms.

The maximum output signal level is 9 volts into a high-impedance load or 4 volts into 600 ohms. The maximum rated output is 7.5 volts. Hum and noise are rated to be at least 86 dB below the rated output, with distortion less than 0.05% at any level up to the rated output and 0.005% at outputs of less than 1 volt.

The only operating control on the expander is a slide-type potentiometer that is used to adjust the sensitivity of the expansion circuit. At its minimum setting, there is no expansion. As the pot is moved right toward maximum, increasing amounts of expansion are introduced, depending on the input signal level. Red LED indicators above the control come on at 2-dB intervals that correspond to 1.5 to 13.5 dB of expansion. (The circuits have a somewhat greater range than this.) Although the LED's are sequentially activated by an analog-to-digital converter, the expansion process is smooth and continuous.

There is no power switch on the expander, which is designed to be powered and deactivated when it is plugged into a switched ac outlet of



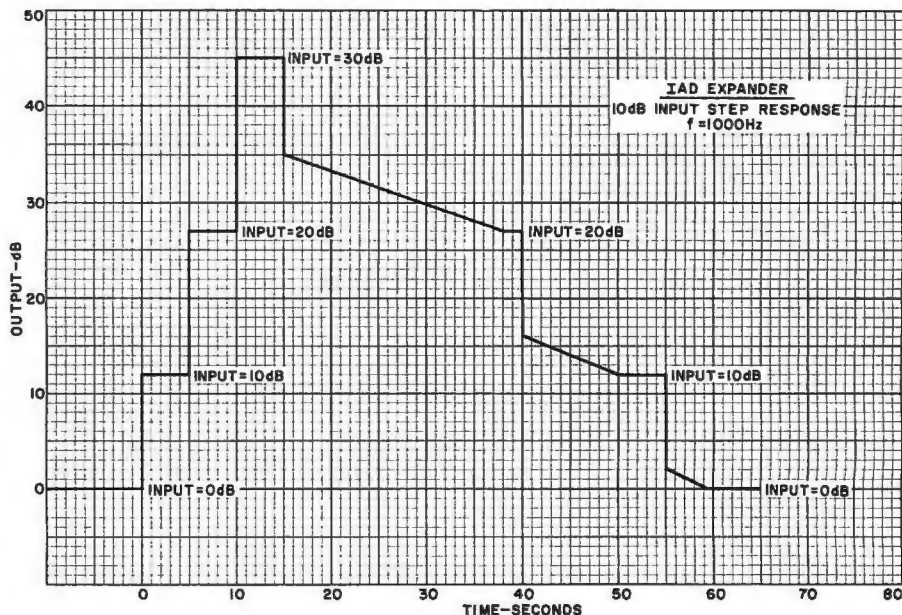
an amplifying system. With a 2-watt power consumption it is practical to leave the expander on at all times if this proves to be more convenient.

**Laboratory Measurements.** The output of the expander clipped at 9 volts into a high-impedance load, as rated. The 1000-Hz harmonic distortion was buried in the noise level below 2 volts output, where it measured 0.006% with no expansion being used. At 7 volts output, the THD measured 0.03% at 20 Hz, 0.014% at 1000 Hz, and 0.013% at 20,000 Hz. With full expansion, the THD was 0.04% at 20 and 20,000 Hz and 0.025% at 1000 Hz. The output noise with IEC "A" weighting measured 76 dB below 1 volt, or 91.5 dB below the rated 7.5-volt output.

With no expansion, the frequency response was as flat as our test instruments, measuring  $\pm 0.25$  dB from 20 to 20,000 Hz. (IAD's rating is  $\pm 0.3$  dB, 5 to 100,000 Hz.) When we applied full expansion, the response appeared to be reasonably flat through the mid-range, being down 1 dB at 200 and 2500 Hz and rolling off to -11 dB at 20 Hz and -12 dB at 20,000 Hz. It was obvious from observing the LED indicators that they did not really represent the response of the expander's amplifiers. Instead, they represent the shaping of the response in its expansion-sensing circuits. Apparently, the expander responds most readily to midrange levels and is less influenced by very low and very high frequencies.

The expander's dynamic behavior was revealed quite clearly when we applied 10-dB increments of input signal level change and plotted the output on a graphic recorder. Starting from a low signal level (our 0-dB reference was below the threshold for the expansion circuit), the first 10-dB increase produced a 12-dB output increase that appeared to be well within the 100-ms rated attack time. The second 10-dB increase stepped the output up by 15.5 dB, while the third 10-dB input increase stepped the output 17.5 dB. Hence, a total increase of 30 dB at the input increased the output by 45 dB. On the time scale of the recorder chart, the increases appeared to be instantaneous.

When we dropped the input signal level from +30 to +20 dB, the output dropped 10 dB, following the input change. However, the gain of the expander then decreased smoothly by



7.5 dB in the next 22.5 seconds. The next step downward, to +10 dB, also appeared at the output as a 10-dB drop, followed by a 5-dB reduction in the next 10 seconds. Finally, the last reduction, to 0 dB, dropped the output by 10 dB to a +2-dB level, with the output dropping to 0 dB (to equal the input level) in another 4.5 seconds.

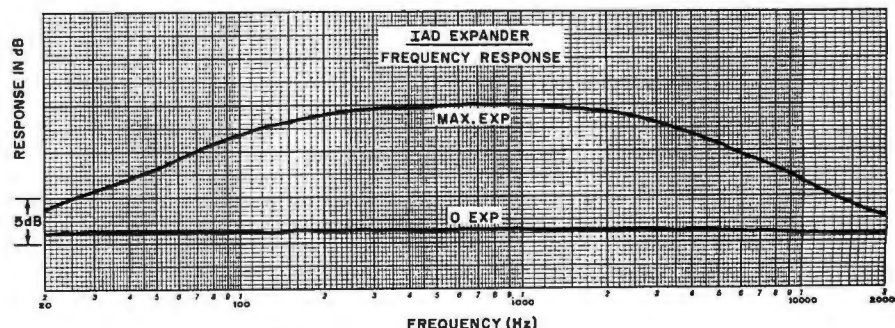
**User Comment.** Our measurements confirmed IAD's claims for the electrical performance of the Model B3A expander. However, the value of the expander can be assessed only by actually operating it in a music system. We connected the expander into several systems and found the tape-monitor connection to be the most practical. Not only does this make the expansion characteristic independent of the volume control setting, but it makes it possible to instantly switch the expander in and out of the system to demonstrate its subjective effect. This is very important if for no other reason than to determine whether or not the expander is really operating.

At no time—regardless of program material, control settings, or other

considerations—were we able to detect the expander in the performance of its function. When none of its LED's were on, switching the expander in and out of the system made no change in the program level. On the other hand, if the LED's indicated considerable expansion, the drop in volume level was dramatic when the expander was bypassed.

The digital operation of the LED's gives the impression that the changes in gain of the amplifiers in the expander also occur in discrete steps. In reality, the changes are so continuous and smooth that one can never detect the expansion action by ear. Depending on where the sensitivity control is set, relative to the program level, one can use the Model B3A as an "upward expander," with the average program level receiving little or no expansion. If you do this, be sure that your amplifier and speaker systems are equal to the task, since 15 dB of expansion will increase the amp's output power by some 32 times compared to what it would be without the expander!

An alternate approach is to use a large portion of the expansion at nor-



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- Most Powerful UHF and VHF Performance Ever.
- New Tri-Linear UHF Director System Extends UHF Reception Distance Up To 30 Miles Farther From Station in Many Areas.

**PLUS...** New Generation FM Antennas.  
High Performance Ruggedized Yagis.  
New Solid State Preamplifiers.



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TELEVISION SYSTEMS

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## NEW TRI-LINEAR UHF DIRECTOR SYSTEM\*

Increases Gain up to 30%!

Provides broader signal capture area in a more compact configuration.

### ORDINARY UHF Director System.



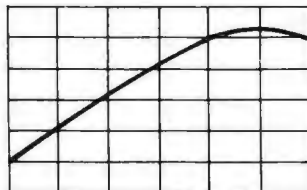
5½"

Uses half-wave directors approximately 5½" long which respond primarily to the high end of the band, with very little gain on the low end.



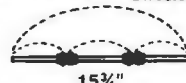
55"

Boom length required for 12 directors



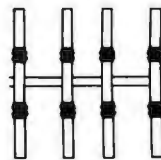
Typical gain curve with ordinary UHF directors.  
Note low response on low end of band.

### WINEGARD High Gain Tri-Linear® Directors



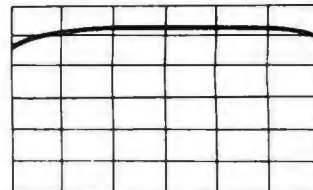
15¾"

Act as 3 half-wave directors on the high end of the band, and re-resonate as a loaded half-wave director on the low end of the band. This results in high linear gain on all UHF channels, giving the antenna sharper directivity and up to 30% more gain over other high gain UHF antennas.



10"

Boom length required for 12 directors

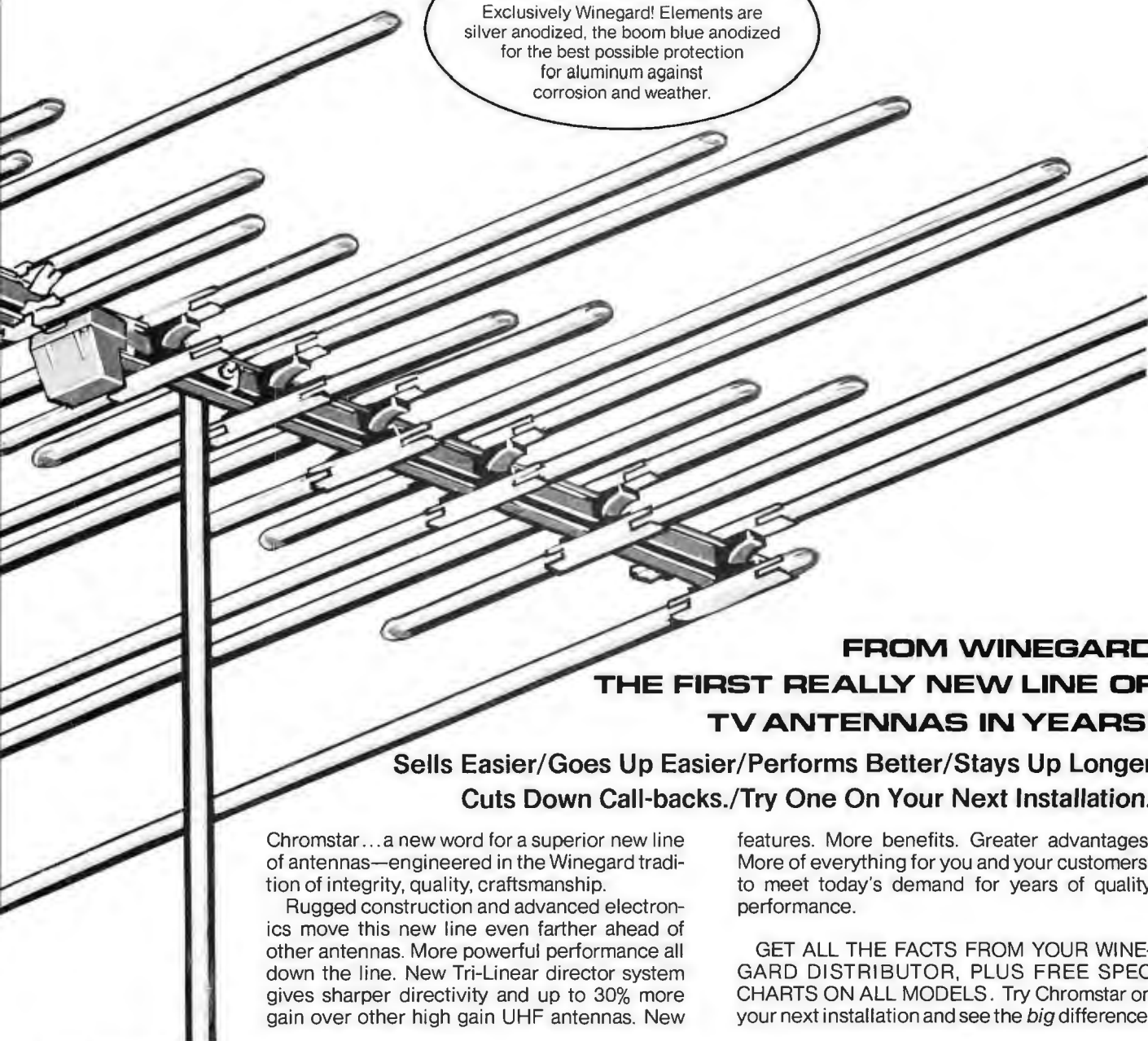


Typical gain curve with Winegard Tri-Linear directors. Note high uniform gain across entire band



## ANODIZED!

Exclusively Winegard! Elements are silver anodized, the boom blue anodized for the best possible protection for aluminum against corrosion and weather.



## FROM WINEGARD THE FIRST REALLY NEW LINE OF TV ANTENNAS IN YEARS!

**Sells Easier/Goes Up Easier/Performs Better/Stays Up Longer  
Cuts Down Call-backs./Try One On Your Next Installation.**

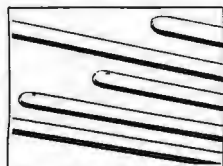
Chromstar... a new word for a superior new line of antennas—engineered in the Winegard tradition of integrity, quality, craftsmanship.

Rugged construction and advanced electronics move this new line even farther ahead of other antennas. More powerful performance all down the line. New Tri-Linear director system gives sharper directivity and up to 30% more gain over other high gain UHF antennas. New

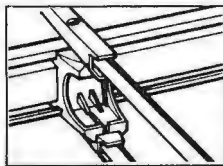
features. More benefits. Greater advantages. More of everything for you and your customers, to meet today's demand for years of quality performance.

GET ALL THE FACTS FROM YOUR WINEGARD DISTRIBUTOR, PLUS FREE SPEC CHARTS ON ALL MODELS. Try Chromstar on your next installation and see the *big* difference.

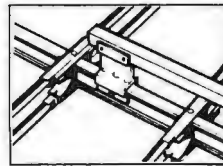
**RUGGEDIZED!** Chromstar antennas are designed to defy weather and wear—are engineered for extra strength at all points of stress. You can actually see the difference in the rugged construction.



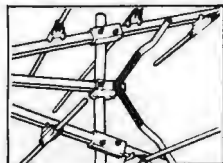
Exclusive  $\frac{3}{8}$ " diameter aluminum tubing for 30% greater strength, better performance, longer life. Winegard is the first and only manufacturer to use this larger diameter.



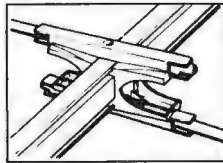
New truss-type phasing bars, top and bottom, with more conductive surface, give maximum transfer of signal. Truss-type "bridge" construction more than doubles boom strength.



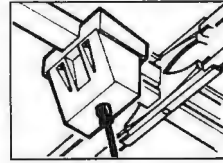
Double boom on longer flat line models for extra strength & rigidity.



New scissors-type struts between upper and lower booms and center boom on wedge models, for extra support, easier installation.



High-impact girder design support insulators are moulded of super-tough Noryl G-E plastic. Four positive locks give maximum support and permanent alignment.



Critical-point weather protection! "New compact weatherproof cartridge housing for downlead, preamplifiers and filter modules. New printed circuit downlead module with both twin lead and 75 ohm coax connections. No separate matching transformer required.

**TV ANTENNAS MORE PEOPLE LOOK UP TO**

mal program levels (turning down the amp's volume control and raising the expander's sensitivity control to restore the lost volume). Then the Model B3A acts as a "downward expander" and in the process reduces noise and hum by as much as 15 dB. In this mode, soft passages may become nearly inaudible. For our purposes, the best mode was an intermediate stage, with the third or fourth LED on at average program levels. This provided a useful amount of expansion as well as some noise reduction.

The effectiveness of the expander depends to a great extent on program

dynamics. With most records and tapes, especially where the program has been allowed to retain some of its dynamic content, the results are nothing short of fantastic. A commercially taped piano solo, for example, was reproduced with its pianissimo portions barely audible, while fortissimo passages drove the amplifier to more than 200 watts/channel output. The sound was highly realistic, since one never had the sense that the system's gain was being manipulated.

It is our opinion that the IAD Model B3A can restore a substantial amount of the compressed dynamics to much

of today's recorded program material. The degree to which its function can be utilized depends to a great extent on the capabilities of the power amplifier and speaker systems with which it is used. We found the expander to be compatible with good 30-watt/channel receivers as well as with super-power amps in the greater than 200-watt/channel class. In any event, we cannot imagine any way in which the expander could degrade any program fed through it if the amplifier and speaker system ratings are not exceeded.

CIRCLE NO. 65 ON FREE INFORMATION CARD

## SHURE MODEL M95ED STEREO PHONO CARTRIDGE

*Moderately priced, it has "sound" of more costly V-15 Type III.*



The new Shure M95ED stereo phono cartridge falls between the company's top-

of-the-line V-15 Type III and its moderately priced Model M91ED. The new cartridge has a pole piece that is similar to the one used in the Type III, although it is not constructed of laminated elements. The design makes possible a lower winding inductance, which results in a flat frequency response that is almost identical to that of the Type III. A low stylus mass of 0.5 mg promises excellent high-frequency "trackability."

The physical appearance of the cartridge is similar to that of the Type III, including an integral swing-away stylus guard as part of the replaceable stylus assembly. The trackability of the cartridge throughout the audio range is such that at its nominal operating force of 1 gram it is about equal to the Type III operating at 0.75 gram.

The retail price of the Shure Model M95ED stereo phono cartridge is \$59.95.

**Laboratory Measurements.** We installed the cartridge in the tonearm

of a high-quality record player for our tests. Operating the cartridge at a 1-gram tracking force, we soon confirmed that it was able to track very high velocities at low and midrange frequencies on our Cook and Fairchild test records. With another tracking test record, produced by the German Hi-Fi Institute, the cartridge tracked 300-Hz tones recorded at a 60-micrometer amplitude without distortion at 1 gram. At its maximum rated force of 1.5 grams, it was able to track the 90-micrometer band on the record. (Most fine cartridges can track 60 to 70 micrometers, but few can cope with the higher levels.)

High-frequency tracking ability tests using the specially shaped 10,800-Hz tone bursts of the Shure TTR-103 test record revealed the excellence of the cartridge's high-frequency performance. Tracking distortion was on a par with the best cartridges we have tested. A more conventional intermodulation-distortion (IM) measurement with the Shure TTR-102 record that mixes 400- and 4000-Hz tones indicated that the IM was only 2% maximum up to 22.5 cm/s.

The output from the cartridge at 3.54 cm/second was 4.3 mV/channel. The stylus's resonance of about 20,000 Hz revealed itself as a ringing of several cycles on a 1000-Hz square wave from the CBS STR/111 test record.

Initially, we tested the cartridge's frequency response with the standard cable and tonearm capacitance of the record player (200 pF, which is typical

for many players). The response had a peak of about 4 dB at 16,000 Hz. Since Shure recommends a load capacitance of 400 to 500 pF for flattest response, we added capacitance to bring the total to 440 pF and measured the response again. This time it was notably flat, varying  $\pm 1$  dB from 40 to 17,500 Hz and dropping to -4 dB at 20,000 Hz. The separation, which was identical on both channels, was better than 30 dB at frequencies below 2000 Hz and gradually reduced to 17 dB at 10,000 Hz and 5 dB at 20,000 Hz.

**User Comment.** Comparing Shure's specifications for the new cartridge and the slightly less expensive M91ED, the only apparent difference is 2 dB greater "trackability" at 400 Hz for the former. Although this is certainly desirable, it would not in itself warrant the creation of a new cartridge. The real difference, however, is in the sound quality of the two cartridges.

The M91ED has a slightly depressed output in the upper midrange that gives its response curve a "sway-backed" appearance. On the other hand, the M95ED has the same flat response characteristic as the V-15 Type III. Therefore, although it is priced nearer the M91ED, it can sound very much like the costlier Type III.

We compared the M95ED to the M91ED because the two are very close in price. In an A-B comparison, the latter had a warmer, somewhat heavier sound, while the M95ED was brighter and sharper in its apparent definition. It would be impossible to



say that one cartridge sounds better than the other—only that each has a different sound that must be judged by the listener.

If you like the "sound" of the expensive V-15 Type III, the M95ED should be a moderately priced alternative.

CIRCLE NO. 66 ON FREE INFORMATION CARD

## YAMAHA MODEL CR-800 AM/STEREO FM RECEIVER

Medium-power unit has superb FM performance.



Ranking next to the top of Yamaha's receiver line is the Model CR-800. This AM/stereo FM receiver is very conservatively rated at 45 watts/channel into 8-ohm loads. The receiver features top-quality performance and a full complement of controls. It has the distinctive Yamaha equipment styling, characterized by a clean, uncluttered satin-aluminum front panel and large dial cutout area.

The receiver measures 17¾"W × 11¾"D × 6¼"H (45.1 × 29.8 × 15.9 cm) and weighs 31 pounds (14 kg). It retails for \$580.

**General Description.** The relatively short FM dial scale is linearly calibrated at 0.5-MHz intervals. To the left of the scales are the FM zero-center and AM/FM relative signal strength meters, the latter calibrated logarithmically over a 100-dB range. Three red LED's to the right of the scale indicate when the receiver is on, when a station is tuned in, and when a stereo-FM transmission is being received.

The large tuning knob is located to the right of the dial window. All other controls are located on the lower half of the receiver's front panel. Lever switches are provided for controlling receiver power, a 20-dB audio attenuator for temporary level reduction, stereo/mono switching, and the filters. Three-position, center-off switches are used for the filters.

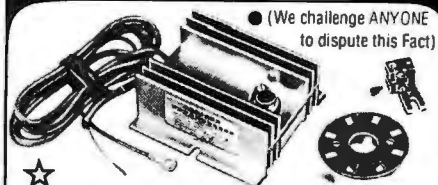
The low-cut filter provides a choice of 20- or 70-Hz cutoff frequency, with a 12-dB/octave slope. When the high-

cut filter is in its down position, it introduces a 6-dB/octave rolloff beyond 8000 Hz. In the up position, it partially blends the high audio frequencies to reduce noise on stereo programs. The center positions of both switches disable the filters. (Many receivers use a similar system for stereo FM noise reduction, but this Yamaha receiver is the first we have seen to apply it to all program sources.)

The BASS and TREBLE controls have 11 detented positions. The BALANCE control is a center-detented ring concentric with the VOLUME control. A separate LOUDNESS control, also with 11 detented positions, gradually introduces bass and treble boost as it lowers the midrange level. It is used in conjunction with the VOLUME control to provide correct low-level volume compensation that is independent of the setting of the VOLUME control. A separate MICROPHONE volume control, with an OFF position, is provided for adjusting the level from a microphone plugged into an adjacent jack.

The other controls are rotary switches, operated by bar knobs whose settings can be seen at a glance. One switch is for activating either, both, or neither of two pairs of speaker systems connected to the receiver's outputs. Another is for controlling the interface between the receiver and two tape decks. In its center position, the selected program source is heard through the speaker systems. Moving it one position to either side of center permits monitoring of the playback output from either tape deck. An additional two positions per-

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Here's a \$29.95 option that's a marvel of convenience, too. Big ¾" numbers appearing just below the channel numbers tell you the exact time every time you change channels. Right down to the second, if you wish. And it displays in 12 or 24-hour format.

#### Fixed-Filter for Best Pictures Longer

Unique. Exclusive. Heath-designed circuitry incorporates a fixed L-C type filter with an integrated-circuit IF amplifier to

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And more integrated circuits than any. The only tube in these sets is the picture tube. This sophisticated circuitry gives you less interference, truer colors, more precise, reliable tints, improved sensitivity, greater noise immunity, and better picture definition. Solid long-life performance.

#### The Differences

**Tuning.** In the 25v and 21v sizes, you get Total Electronic Touch Tuning. Silent varactor tuners, no moving parts. A programmable digital counter controls the tuning—sweeping up or down the 16 pre-selected channels. And remote control of all functions is just \$89.95. In the small screen sizes, the tuning is all-channel detent type.

**One-Button Picture Control** in the three

smaller sets restores brightness, contrast, color and tint to pre-set levels at the touch of a button. Child-proof performance.

**Latest-design Picture Tubes.** In the two larger sets you enjoy brighter pictures with greater contrast thanks to the deluxe Black (negative) Matrix tubes. The three table models use picture tubes with the new precision in-line gun and slotted shadow mask for greater light output and picture realism.

#### Easier to build and service.

Plug-in circuit modules and wiring harnesses make these sets the easiest to build of all. And the new digital-design Dot Generator, slide-out Service Drawer and Test Meter make self-service easier.

#### Compare the value.

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②

### NEW High Fidelity AM/FM Table Radio

At last, a table radio worth listening to... one that performs like hi-fi components. 5  $\mu$ V sensitivity; ceramic filters for 60 dB selectivity; and an output power of 5 watts, minimum rms, at less than 1% total harmonic distortion, from 60 to 15,000 Hz into its 8 ohm full range high compliance speaker. The closed cabinet features a teak wood grain vinyl covering and black, molded double-knit jersey front panel. Kit GR-1085, \$99.95



③

### NEW Programmable Electronic "Doorbell"

Put a song at your doorstep with this unique kit. Program it to play your favorite song. C through C' "keyboard" with plug-in leads for up to 16 notes. Change your tune when you wish to celebrate a season, anniversary, birthday, or special party. One watt sound power; controls for tuning, volume, speed, and decay characteristics. Kit TD-1089, \$44.95



④

### NEW versatile, low cost 5-digit counter

Measures frequency from 5 Hz to 30 MHz, period to 99.999 seconds, counts events to 99,999, and it will operate on 120 VAC or 12 VDC. As a freq. counter it will resolve to 1 Hz; sensitivity is 15 mV above 50 Hz, 50 mV below 50 Hz. In the period mode, it will resolve to 1 msec. Has Over-range indicator; gate lamp; 3-position input attenuator; 10 MHz time base. Kit IM-4100, \$129.95



5

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put. Hum and noise are 80 dB below a 0.25 v. input even in the high-level section. A phono preamp with over 94 dB dynamic range — better than most records! Versatile control center. Special speaker protecting circuitry. Four lighted output meters with 40 dB dynamic range. Separate bass, treble, and level controls for front and back channels. Master volume control. 21 pushbutton switches that light when activated. They include: output; inputs (stereo phono, CD-4, aux., tape, tape monitor, dubbing AM and FM); mode (mono, stereo front channels, stereo 4 channels, SQ, and discrete 4-channel); high filter; low filter; loudness; tone flat; squelch defeat; FM Dolby; and power. Use it as a tuner only, as a driver for your present power amps, as a control center for taping, so good you can even use it as a broadcast station monitor. Kit AN-2016, \$599.95

Expand your MODULUS system with your choice of stereo power amplifiers. Module II is the medium power AA-1505. Module III is the high power AA-1506.

35 or 60 watts, min. RMS, per channel into 8 ohms at less than 0.1% distortion from 20-20,000 Hz. Styled to match the Module I tuner/preamp. Add one of either power level for a stereo receiver; add two for a 4-channel receiver. Kit AA-1505, \$159.95; AA-1506, \$179.95

Choose your mode and input. Module IV is the FM Dolby module AD-1504 for reduced noise and greater dynamic broadcast range (\$39.95). Module V is the CD-4 Demodulator for the spacious sound of CD-4 discrete 4-channel records (\$79.95). Module VI is the SQ Decoder for quadrasonic separation of matrixed material; full logic and variable blend (\$49.95). All are housed inside the tuner/preamp module.

### A "Living" music system.

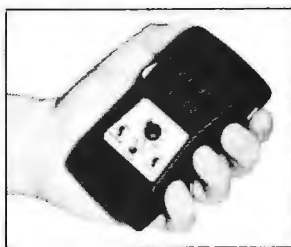
MODULUS is designed for you — the way you live — today and tomorrow. It can grow with you, adapt to your changing life style, flex with changing technology. Whatever your desires in music systems, now and later, MODULUS.



6

## NEW 3-Way Speaker

Looks and sounds like it should cost \$100 more! High performance 3-way system has a 10" woofer, 4 1/2" mid-range, 1" dome tweeter. Drives with 10 watts, yet a super-power amp reveals its unusual dynamic range and high power handling capabilities. Enclosure has walnut veneer on all sides and front for use without the black foam grille. Tweeter and front-mounted switch plate are interchangeable for optimum imaging in horizontal or vertical position. Kit AS-1373, \$149.95



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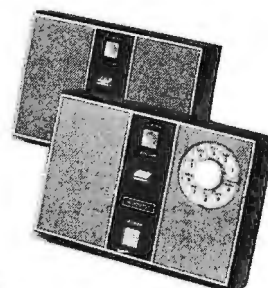
## NEW Digital Stopwatch

Programmable — for the time of your sporting life. You program in a time (up to 9 hours, 59 min., 59 secs.) and it will count up to that time or down from it to zero. Or it will count 99 hours, 59 mins., 59:99 secs. in the five other functions which include: Start/Stop Elapsed; Sequential; Total Activity; Split; & Start/Stop Activity. 8 digits & 2 IC counters with accuracy to  $\pm 0.003\%$  & resolution to 1/100th second. Jacks for external trigger and alarm. Includes nickel-cad. batteries & charger. Kit GB-1201, \$99.95

8

## NEW 2-Way Telephone Amps

Amplified "talk" and amplified "listen", with or without dialer. Real hands-free convenience — use from 10' away. VOX control silently switches from built-in microphone to speaker without clipped words or feedback squeals. GD-1112 works with regular phone. GD-1162 with built-in dial and electronic ringer works like an extension phone. Easy to build, convenient for use at home or office. Kit GD-1112, \$49.95; Kit GD-1162, \$69.95.



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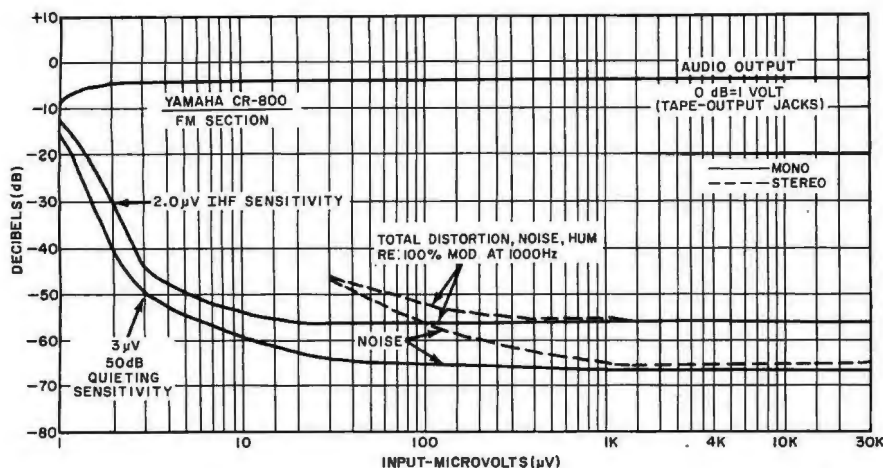
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0.03% from 0.7 to about 60 watts output. The IM distortion was less than 0.03% from 0.1 to 30 watts, reaching 0.05% at 60 watts output. (The conservatism of the receiver's ratings is illustrated by its rated 45 watts/channel from 20 to 20,000 Hz at less than 0.1% THD.)

At the rated 45-watt output, the distortion was less than 0.035% from 20 to 20,000 Hz, typically measuring less than 0.015%. It was roughly the same at half power and even at one-tenth power did not exceed 0.06% over the full audio range.

A reference 10-watt power output required an input of 57 mV at the Aux, 1.2 mV at the PHONO, and 1.1 mV at the MIC inputs. The respective unweighted S/N figures were 80, 78, and 74 dB, referred to 10 watts. These represent exceptionally quiet amplification, especially through the low-level PHONO and MIC inputs. The phono preamp overloaded at a very high 250 mV, while the microphone preamp input overloaded at 700 mV—a new high in our experience with receivers and amplifiers.

The receiver easily handled the one-hour preconditioning period at one-third power before the distortion and power measurements were made. Even more remarkable, it was accidentally subjected to 30 minutes of severe overloading, driven into hard clipping on both channels, without suffering any damage.

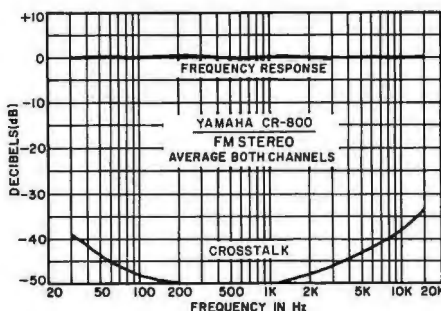
The RIAA phono equalization was accurate to within  $\pm 0.5$  dB from 30 to 20,000 Hz. It was affected by cartridge inductance to about the same extent as most good amplifiers and receivers, with a reduction of output at 15,000 Hz of 1 to 2 dB, depending on the specific cartridge used.

mit connecting the recorders for dubbing from either machine to the other. (The normally selected program source is not heard in this mode.) Finally, the desired program source is selected by a switch with positions for AUX, two magnetic PHONO cartridges, FM with and without interstation noise muting, and AM. A headphone jack is located below the microphone jack.

On the rear apron of the receiver are the various inputs and outputs, plus separate preamplifier outputs and main amplifier inputs that permit independent operation of the two receiver sections or insertion of accessories (active equalizer, active cross-over system, etc.) The inputs are normally joined to the outputs in pairs by an adjacent slide switch. The speaker outputs are insulated spring clips. An IF OUT jack is presumably intended for use with a 4-channel FM adapter. In spite of its nomenclature, it is apparently a detected composite stereo signal without deemphasis.

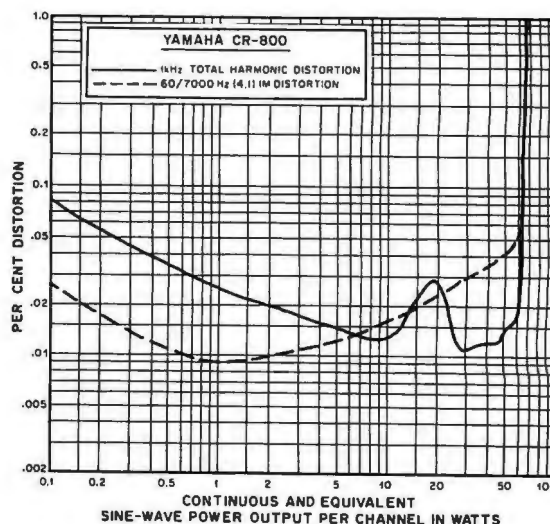
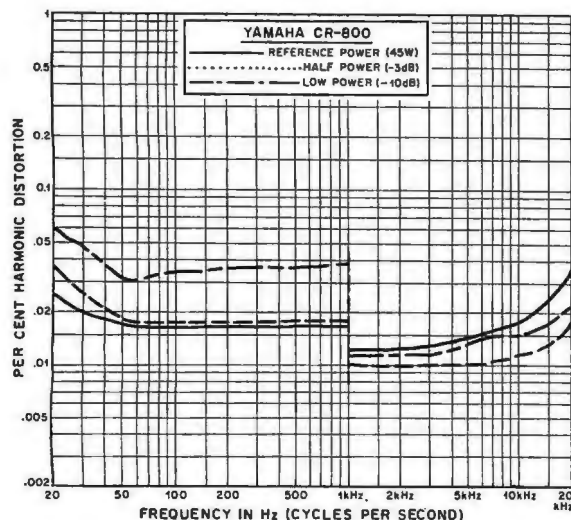
There are antenna inputs for 300- and 75-ohm FM antennas and a wire AM antenna, plus a pivoted ferrite rod

AM antenna. Two of the four accessory ac outlets on the rear apron are switched.



**Laboratory Measurements.** The measured performance of our test receiver speaks for itself. In virtually every respect, the receiver far surpassed its published ratings!

With both channels driven into 8-ohm loads at 1000 Hz, the audio outputs clipped at 61 watts/channel. Into 4- and 16-ohm loads, clipping occurred at 79 and 41 watts/channel, respectively. The THD at 1000 Hz was below the noise level up to several watts output. It measured less than





The filters had the rated characteristics, with excellent low-cut action but a gradual high-frequency rolloff that was of little use in hiss reduction. The tone controls had considerably more range at the low than at the high frequencies, the former with a sliding inflection point and the latter with a hinged characteristic.

The loudness compensation was both unusual and effective. The first few steps of loudness reduction produced only a trace of low- and high-frequency boost. Further operation of the control provided the rather extreme characteristics of most loudness-control systems.

The FM tuner's IHF usable sensitivity measured 2.0  $\mu$ V. Its 50-dB quieting sensitivity was 3.0  $\mu$ V. The stereo switching threshold (and the muting threshold) was between 15 and 22  $\mu$ V. This is somewhat high for such a sensitive tuner, but it does assure that all received signals will be of good quality. The ultimate unweighted S/N ratio was 67 dB in mono and 66 dB in stereo. At 1000  $\mu$ V, the distortion was a low 0.15% in both mono and stereo.

The FM capture ratio was an outstanding 0.9 dB, and the AM rejection was far above average at 70 dB. Similarly impressive measurements were obtained for image rejection (79 dB) and alternate-channel selectivity (88 dB). The 19-kHz pilot carrier leakage into the audio outputs was unmeasurable, being more than 85 dB below the 100% modulated program level.

The stereo FM frequency response was literally ruler-flat, with a variation of less than  $\pm 0.3$  dB from 30 to 15,000 Hz. This is especially noteworthy in

view of the pilot carrier rejection of the receiver, since most tuners use low-pass filters for rejection to prevent appreciable attenuation at 15,000 Hz. The stereo channel separation exceeded 40 dB from 30 to 7500 Hz and 50 dB from 150 to 1500 Hz. It was still a healthy 33 dB at 15,000 Hz.

The AM frequency response was down 6 dB at 140 and 3200 Hz.

**User Comment.** As the laboratory tests reveal, this is a receiver that invites the use of superlatives. For example, the FM tuner performance comes close to matching that of the \$1200 Yamaha Model CT-7000 FM tuner and is far better than what we would expect from a receiver at any price. The convenient FM tuning system features afc defeat when the TUNING knob is touched and dimly lights the AFC/STATION LED on the dial when a signal is properly tuned. Releasing the knob permits the afc to gradually come on, bringing the LED to full brilliance. Although afc is certainly not needed to correct for drift, which is essentially nonexistent, it makes the tuning procedure simpler than it would otherwise have been.

The dial calibrations were very accurate and easy to read against the hair line on the movable illuminated plastic indicator. The tuning meter gives a useful indication of relative signal strength, from levels too weak to operate the muting system to the highest that will ever be encountered. All the controls operate smoothly and with positive action, and a total lack of unwanted electrical transients must be experienced to be appreciated.

The FM muting system is one of the best we have used. It had no trace of thumps or noise bursts. As with most stereo receivers, the AM section of the Model CR-800 is below "hi-fi" quality, with the contrast made even more vivid by the superb FM performance of the receiver.

We usually take a dim view of loudness-compensation systems, which tend to make everything sound boomy and unnatural. However, with the system in this receiver, we make an exception. When the control is set to maximum and the volume is set to the loudest level you expect to use, reducing the LOUDNESS control setting preserves a natural frequency balance. At the lowest settings, the compensation becomes rather great. Over most of its range, one is hardly aware of the action of the loudness compensation, which is as it should be.

Obviously, our experience with the Model CR-800 receiver has left us enthusiastic. There are a few other receivers whose quality is similarly above reproach, and we would not attempt to rank them in any order of preference. On the other hand, we can say with assurance that we have never used a stereo receiver whose performance surpasses that of the Model CR-800 in any significant respect. Other receivers might be more powerful or have some features lacking in this one, but none can outrank it in sheer performance and attention to the small details of human engineering that make it such a satisfactory product.

CIRCLE NO. 67 ON FREE INFORMATION CARD

## ELECTRA BEARCAT 101 "DIGITAL" SCANNING MONITOR

*Vhf-uhf scanner programs 6000 frequencies without plug-in crystals.*



**T**HE Bearcat 101 from Electra offers something new in the way of a scanning FM monitor receiver. Highly advanced, it contains the latest

in modern technology, including a computer-type digital frequency-synthesis system that eliminates the need for plug-in crystals. The receiver

provides scanning of 16 frequencies in the 30-to-50-MHz low-uhf, 148-to-174-MHz high-uhf, 416-to-450-MHz uhf, and 470-to-512-MHz T uhf Public Safety bands. Included in the coverage is the 146-to-148-MHz segment of the 2-meter Amateur radio band.

Any 16 out of more than 15,000 possible frequencies in these bands can be set up in any order or band combinations or be changed by the user simply by programming them from the front panel.

In operation, the appropriate r-f circuits for each band are automatically switched in and tuned for each frequency. This ensures peak performance over the entire range of each

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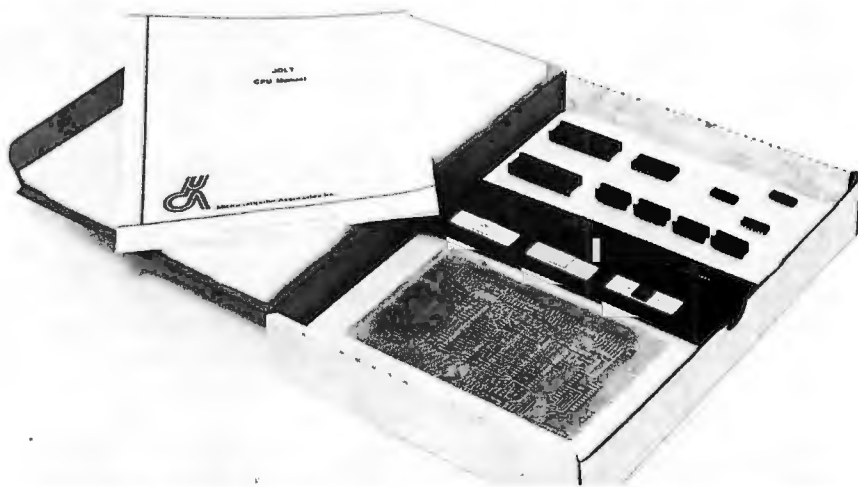
**JOLT™ is the new, fully-tested microcomputer with the exclusive on-board DEMON™ debug monitor. You can build it, plug it in and talk to it in three hours or less . . . for a price of just \$249!**

The basic JOLT™ card includes an 8-bit MOS Technology Model 6502 CPU, which requires no clock, can directly address 65k of memory, has two index registers, 58 instructions with 11 addressing modes, two interrupts and includes both single step and address halt capability. And that's only a part of it.

JOLT's™ CPU card is available IMMEDIATELY\* in either kit form or assembled (\$249 for the kit in single quantity and \$348 assembled). Either way, the JOLT™ CPU is completely tested prior to delivery. It comes complete with a terminal interface (TTY or EIA) and a unique software Debugger/MONitor called DEMON™, for which full documentation is provided. It is very easy to program, and any JOLT™ delivery includes an easy-to-follow assembly instruction manual, showing you exactly how to put everything together . . . correctly. Complete assembly should take you no more than three hours if you choose the CPU in kit form. Besides the JOLT™ CPU — the 6502 from MOS Technology — the basic JOLT™ card has a fully static memory accommodating 512 bytes of the user RAM. The JOLT™ CPU memory also has 64 bytes of interrupt vector RAM. ROM Program memory on the basic card consists of 1k bytes of monitor/debugger with an automatic Power-On bootstrap program — so you can start talking to JOLT™ and it to you as soon as you plug it in to your terminal. On-board Input/Output devices on the JOLT™ CPU card include TTY 20 milliamp current loop and an EIA interface, both full duplex. The card has high speed reader interface lines and 16 fully programmable user I/O lines with full TTL drive.

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The exclusive DEMON™ Debug Monitor really makes JOLT™ one of the most outstanding computer systems offered at any time, at any price. Even without DEMON™ and its superior software features, JOLT™ is the lowest cost computer system in existence. And DEMON™ is a bonus you'll have to use to believe. First, it self-adapts



*All kits are delivered with a complete instruction manual and packaged for easy visual identification of parts to aid you in assembly.*

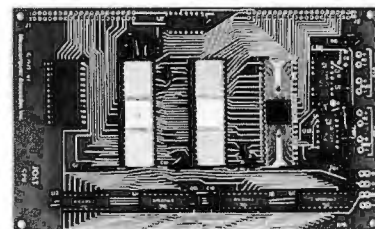
to any terminal speed from 10-30 CPS. With it, you can display and alter your CPU register and memory locations, plus you can read, write and punch Hex formatted data . . . with Write/Punch BNPF format data for PROM programmers. It has unlimited breakpoint capability along with separate non-maskable interrupt entry and identification. External device interrupts can be directed to any location you choose, or they can be defaulted to DEMON™ recognition. DEMON™ also gives you (1) a completely protected ROM resident debug/monitor; (2) the capability to begin execution at any location in memory; (3) the capability to bypass DEMON™ entirely to permit full control by you over your system; (4) a high-speed 8-bit parallel input option; and (5) it includes user callable DEMON™ I/O subroutines. MOST IMPORTANT, DEMON™ IS INCLUDED AS STANDARD WITH ANY JOLT™ CPU KIT OR ASSEMBLED BOARD!

**Obviously, the JOLT™ basic card is a computer in and of itself. But you can add significantly to its capacity and versatility by adding 4k RAM JOLT™ memories — in one card or a whole bunch. A RAM card kit is only \$265 (\$320 assembled). Now.**

The JOLT™ memory card is a fully static 4,096-bit Random Access Memory (RAM) with 1 microsecond access time and on-board decoding. It is also available now.\*

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**There's also a JOLT™ I/O card for you, our Peripheral Interface Adapter. You can't beat the price — single kit 96 bucks — or the function.**



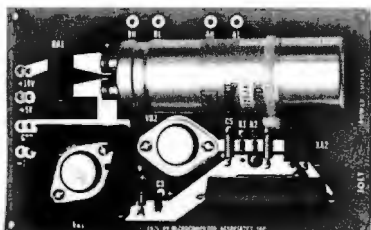
*Pictured above is the assembled JOLT™ CPU card with DEMON™. just plug it in and you're ready to go.*

The JOLT™ PIA (Peripheral Interface Adapter) I/O card includes two PIA LSI chips, 32 input/output lines, two interrupt lines, on-board decoding and standard TTL drive. It is also fully programmable and available IMMEDIATELY\* in either kit or assembled form . . . at a very attractive single unit price (\$140 assembled).

**Considering the function and capacity of the JOLT™ Power Supply Card, you probably think the quantity of one price — \$145 — is a misprint. It isn't.**

The JOLT™ family also includes a power supply card, which operates at any of

three voltages — +5, +12 and -10. The power supply supports the basic JOLT™ CPU card, plus 4,096 bytes of RAM and I/O. The only two words for the price are "dirt cheap." It is available for delivery immediately with a single unit kit price of \$145 (\$190 assembled).



The assembled power supply card shown above powers the JOLT™ CPU, I/O, and RAM Memory cards.

You can also choose a blank JOLT™ universal card. Or several.

The JOLT™ Universal card is completely nude. It's a blank you can use any way you wish, for control panels, T.V. interfaces, keyboards, LED's, or any other interface logic, because the card's holes are drilled to accept 14, 16, 24, or 40 pin sockets and has the same form factor as the other JOLT™ cards. The single unit price is just \$25.

**If you think you need extra cables, wires and the like, choose a Super Value JOLT™ Accessory Bag. A \$55 Value for just \$40.**

The JOLT™ Accessory Bag includes 25 separate parts, enough hardware to connect one JOLT™ card to another. Order an Accessory Bag for each additional JOLT™ card. The Bag contains such necessary items as flat cable, connectors, cord spacers, hardware, wire, etc.

#### THE JOLT PLAIN ENGLISH WARRANTY

All components in the JOLT™ family are new and fully tested prior to shipment. Kit components are fully warranted during the first 60 days of ownership. Assembled parts are fully warranted during the first 6 months of ownership. If your properly assembled kit does not work, just ship your order back to Microcomputer Associates Inc. and we'll repair, replace, or refund your money.

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band (there are no restrictions as to the band-coverage limits). Each channel can also be set up for automatically providing a one-second rescan delay or no delay at all at a particular channel.

Among the customary features to be found are LED channel indicators, manual/automatic scanning, channel-disable switches, adjustable squelch, volume control, front-facing speaker, telescoping whip antenna, jacks for external antenna and speaker, and terminals for connecting an accessory. A kit consisting of a power converter and mounting hardware is available for mobile installations. Operated from a 117-volt ac line, the receiver draws 30 watts of power.

The receiver measures 9"W x 7 1/4"H x 3 5/8"D (23 x 18 x 9 cm) and weighs 6 1/4 pounds (3.8 kg). Suggested retail price is \$349.95

**Technical Details.** The receiver employs a single-conversion design, to a 10.8-MHz i-f. Selectivity is provided by a six-pole monolithic crystal filter. High sensitivity, low noise, and good signal-handling capabilities are obtained by use of dual-gate

MOSFET's in the r-f and mixer stages for the vhf bands. Uhf-band operation is optimized by a separate r-f and mixer system that uses bipolar transistors. IC's are used in the i-f, detector, and a-f (including the output) stages.

Each band to which the receiver can be tuned has its own separate r-f circuit. The circuits are automatically selected according to the frequency for which the working channel is set. Tuning to each frequency is accomplished by variable-capacitance diodes that are controlled by the programmed information set up for each channel. Hence, the sensitivity/gain characteristics are uniform over the entire range for which the receiver can be set.

Our measurements, conducted with 50 ohms across the antenna input terminals, indicated 20 dB of quieting with a 0.35-to-0.4- $\mu$ V input signal and a usable sensitivity of about 0.25  $\mu$ V on the lower bands. The sensitivity dropped off somewhat on the uhf bands.

The maximum extension of the telescopic whip antenna was 22 1/2" (57.2 cm). This is quite short for the 30-to-50-MHz band. However, the efficiency is raised by an antenna-loading inductor that is automatically switched in when this range is used.

**Frequency Synthesizer.** Custom-designed MOS and TTL IC's are used for scanning at a rate of about 20 channels per second for the frequency-synthesis system. The synthesizer employs the method in which a standard reference signal is derived from a crystal-controlled master oscillator or clock. The local oscillator signal at the receiver's mixer is obtained from a voltage-controlled oscillator (vco).

A vco comparison signal, obtained via a programmable counter-type divider system, is compared against the standard reference in a phase discriminator. Any discrepancy detected creates an error voltage that shifts the vco frequency to the point where these two signals are locked in phase with each other. This results in the proper vco frequency according to the division ratio programmed for the desired channel.

The logic for the switch positions is programmed through a special "non-volatile" memory system that retains the information even after power is removed from the receiver. Therefore, no reprogramming is ever necessary,

unless channel frequencies are to be changed.

**User Comment.** The receiver is initially programmed at the factory for 16 national frequencies. Reprogramming from a choice of 6000 other assigned Public Safety frequencies is easily accomplished by referring to the manual provided with the receiver. Tables in the manual indicate the required operations for each frequency.

The reprogramming procedure is as follows: You push a READY switch, set all channel switches to their down positions, and operate the MANUAL switch to step the LED indicators to the channel number to be programmed. Then, you push up certain channel switches as indicated in the tables for the desired frequency. (The one-second rescan delay for any particular channel can also be programmed at this time.) Following this, you momentarily depress an ENTER momentary-contact switch. Then, by pressing the READY switch to its up position, and placing the channel switches up for only those channels you want to scan, the receiver is programmed to selectively scan.

Manual or automatic scanning is selected and controlled by a separate lever switch. With manual scanning, any one channel can be kept open until scanning is resumed. There is no priority channel.

The two-meter Amateur frequencies are listed in the manual's tables in multiples of 10 kHz. However, the receiver's selectivity was broad enough to allow reception of local repeaters operating at odd multiples of 5 kHz with the scanner set to the nearest 10 kHz multiple.

Our measured selectivity indicated a 10-kHz adjacent-channel rejection of approximately 40 dB. Operationally, with the 148-to-174-MHz assigned channels at 15-kHz multiples, adjacent-channel interference from our local police transmitter (located some 2 1/2 blocks away) produced only a slight buzzing with low-level audio distortion. It was apparent that no significant problems should be expected in this regard.

Best signal efficiency is obtained from the use of an external outdoor antenna, such as a dipole or ground plane designed for the particular frequency band you plan to use. However, we obtained good readability using only the whip antenna supplied with the receiver at our third-floor in-



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door location from signals originating 40 or so miles away.

The output power from the audio section measured 2.5 watts into 8 ohms, with 3% distortion from a 1000-Hz sine-wave signal. At 3 watts

output, the distortion rose to 10%, and the waveform exhibited slight clipping. Audio intelligibility from the front-facing speaker was good to excellent.

CIRCLE NO. 68 ON FREE INFORMATION CARD

### LECTROTECH MODEL BG-10 COLOR GENERATOR

*Battery-powered, miniature generator for field servicing.*

**F**IELD-SERVICE test equipment has come a long way in less than five years. Test gear that once had to be left back at the shop because of its bulk and weight can now be conveniently carried to a field job. A case in point is the color bar/dot generator used in color TV receiver servicing. Older generators were large and heavy and tied to the ac line. Lugging them along on a call was like lugging around an extra tube caddy. Fortunately, that situation has changed for the better.

Lectrotech, Inc., is currently marketing a Model BG-10 color generator that should make every color TV serviceman jump for joy. Measuring a compact 5½"L × 3"W × 1¼"D (14 × 7.6 × 3.2 cm), it is hardly larger than many portable calculators. In fact, it comes in a zipper-type soft vinyl carrying case that resembles many calculator cases.

The color generator is completely independent of ac line operation, using only a pair of 9-volt batteries. The generator's circuit employs low-current-drain CMOS digital IC technology to yield the maximum battery life possible.

The retail price of the generator is \$89.50

**Technical Details.** The color generator is extremely simple to operate. There are only three switches that need concern the user. One two-position switch selects the row in which a desired pattern is located, while a three-position switch is used to zero in on the desired pattern. The front cover is silk-screened with the six patterns available, which are keyed to the switches with heavy black lines. The patterns available include: single dot, three color bars, single vertical/horizontal lines, full-screen dots, full-screen crosshatch, and 10 color bars.

The third switch is labelled COLOR ON/OFF. This switch must be set to ON whenever the three- or 10-bar pattern is selected and to OFF for any other pattern.

There isn't even a power switch per se. To apply power, a mechanical locking mechanism at one end of the generator's case must be squeezed, while the bottom of the case is being slid out, at which time power automatically comes on. (A plastic "cam" on the upper half of the case passes over a leaf switch when the case is opened, closing the contacts. When the case is shut, the cam disengages and opens the contacts.) When power is on, a LED on the control panel comes on. The locking mechanism prevents the case from accidentally opening and running down the batteries, while a mechanical stop prevents the bottom half of the case from sliding all the way out.

The test leads for the generator are permanently built in. They neatly fold away to fit into a small well in the instrument's case. Since it is necessary to open the case to get at the test leads, power comes on automatically and the instrument is ready to use.

The r-f oscillator in the instrument is factory tuned to TV Channel 4. It can, however, be adjusted with a hex tuning wand to provide an r-f output on either TV Channel 3 or 5 if preferred. Access to the tuning slug is provided through two holes in the side of the case that line up when the instrument is on.

**User Comment.** This miniature color generator can do virtually everything the full-sized instruments can do. The major advantage to the serviceman is not so much that it performs like an "in-shop" color generator of five years ago, but that it is small enough to be tucked into a tube caddy without taking up vital space for other supplies and tools.

We used it on a number of service calls and can honestly report that it was a great convenience in terms of getting it to the job and its performance on the job. The fact that this is a battery-powered instrument was greatly appreciated, since an ac outlet is often not available.

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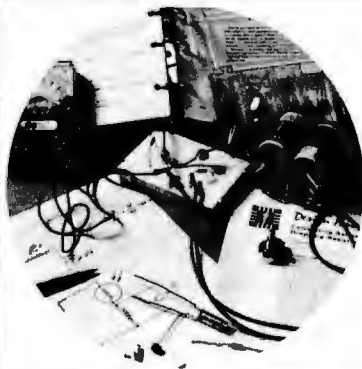
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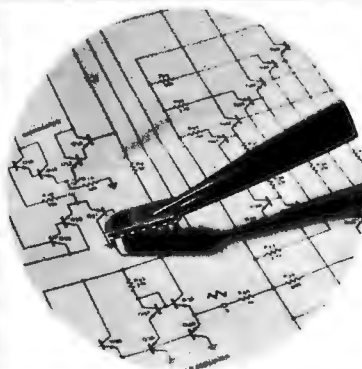


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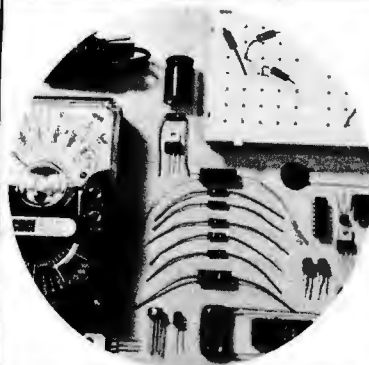


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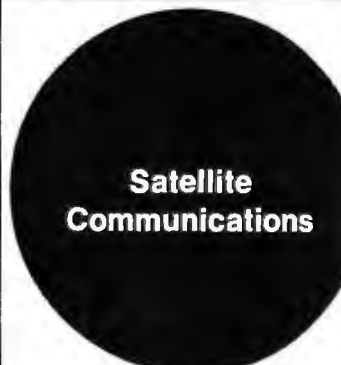
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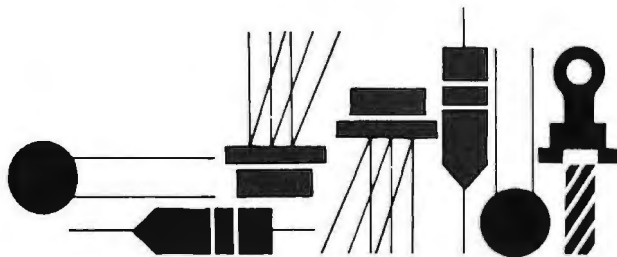
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# Solid State

By Lou Garner

## CALCULATOR CHIPS FOR OTHER CIRCUITS

**U**BIQUITOUS, innocuous and relatively inexpensive, calculator IC's (popularly called "chips" by engineers) are suitable only for the assembly of pocket and desk calculators. Right?

*Wrong!* More and more circuit designers are using these devices in noncalculator applications and, unlikely as it may seem, one day they may be used almost as extensively in other type of equipment as they are in calculators today. Some calculator chips have such powerful capabilities, in fact, that a number of original equipment manufacturers are considering their use in specialized instrument and control systems in place of minicomputer subsystems and expensive microprocessors. One industry executive has predicted that by 1977 not less than 20% of the total calculator chips manufactured will be used in commercial equipment and systems rather than in conventional calculators.

Calculator chips can be used to assemble computers; specialized types of watches and clocks; laboratory, industrial and service test equipment; medical instruments; process monitors; communications equipment; surveillance and security systems; and automotive, appliance and industrial controls. Under development and scheduled for early release (if not on the market by the time this appears in print) is a miniature combination calculator wristwatch.

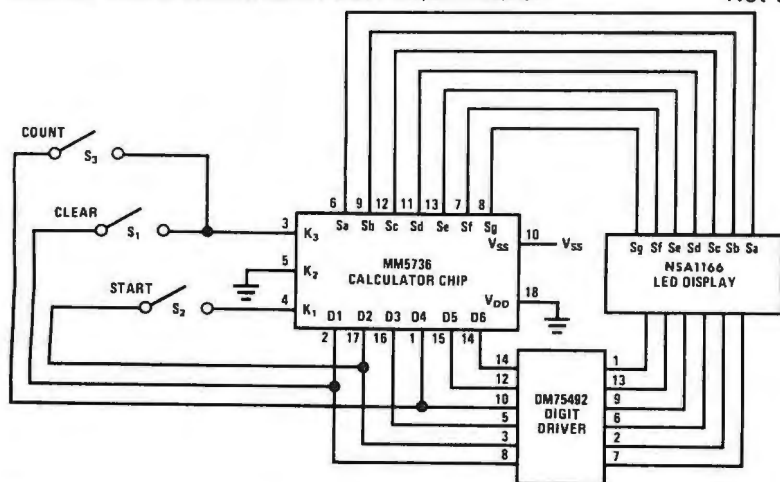
Typical of one class of noncalculator applications, an easily duplicated counter circuit featuring a calculator IC is given in Fig. 1. Abstracted from *Calculator Chip Makes A Counter* (application note AN-112) published by the National Semiconductor Corporation (2900 Semiconductor Drive, Santa Clara, CA 95051), this is the simplest of seven circuits featured in the 6-page publication. The other circuits include a higher speed counter, an "up-down" counter and a combination counter/calculator.

Suitable for either pc or perf board assembly, the counter circuit requires only a type MM5736 calculator IC, a type DM75492 digit driver, a type NSA1166 six-digit LED display, three spst switches, and a 6.5-to-9.5-volt dc power source, such as a standard 9-volt transistor battery. Capable of handling counts of up to 999,999, the circuit's average maximum counting rate is approximately 60 Hz, but the actual maximum rate may range from as low as 40 Hz to as high as 150 Hz due to IC chip tolerances. It can be actuated by a pushbutton, mat, or reed switch, by magnetic relays, by a microswitch, or by any of a number of contact arrangements. Therefore, it is suitable for a wide variety of practical applications. Depending on the type of count control switch (S3), the counter can be used, typically, for inventory control, production line counting, recording game scores, or for counting the number of customers entering or leaving a store or business office.

The counting function is achieved simply by using the calculator chip to add "1" repeatedly. This is accomplished by interconnecting the chip's terminals (K3 and D4) which initiate the "addition" step through an external COUNT switch, S3. In practice, the operator first clears the circuit by depressing CLEAR switch S1, then enters "1" into the count by closing the START switch, S2. From this point, each closure of the COUNT switch causes "1" to be added to the total count up to the display's maximum capability.

By definition, a computer is a device or system capable of solving problems by accepting and retaining data, performing prescribed operations on that data, and supplying and/or storing the results of those operations. If the capability of accepting and retaining a planned program of operations is added to a calculator chip, then, in effect, the calculator/programmer combination becomes a basic computer.

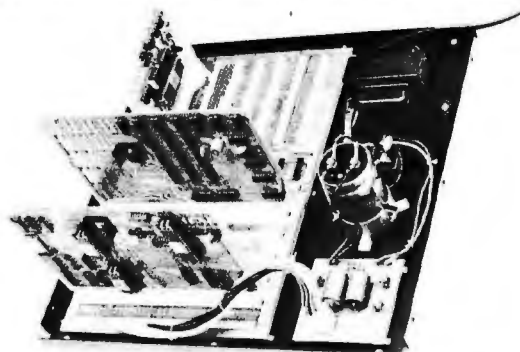
Not too long ago, a programmable calculator required



*Fig. 1. In this six-decade counter circuit (from a National Semiconductor Application Note), a calculator IC and a digit driver control an LED readout. Depending on the type of counting switch used, the circuit has many different applications.*

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several LSI chips to provide the necessary calculation, memory and programming functions, keyboard debounce circuits to prevent false entries, separate segment and digit drivers for the display, a multidigit display, power supply regulation circuits and, of course, a suitable keyboard. As a result, commercial programmable calculators cost as much as several hundred dollars each.

Several months ago, the National Semiconductor Corporation made it possible for equipment manufacturers to design moderately priced programmable calculators when it introduced a series of four special-function single-chip calculator IC's together with a compatible programmer chip capable of converting any of the four chips into a fully programmable "learn mode" calculator. Using these new devices, a programmable calculator can be assembled with only three IC's, a LED display, an appropriate keyboard, a dc power source, and a few small components.

National's five new IC's include the MM5760 slide-rule circuit, the MM5762 business and financial calculator, the MM5763 statistical calculator, the MM5764 international conversion calculator, and the MM5765 calculator programmer. All four calculator chips provide standard arithmetical functions. In addition, the MM5760 offers a complete set of log and trig functions, while the MM5762 provides a single-key computation of present and future value of compound interest, deposit or sinking fund amounts, payment or loan installments, and sum-of-the-digits calculations. The MM5763 includes linear correlation and regression, y-intercept, mean and standard deviation, summation of X or Y values, and related statistical functions. The MM5764 is designed to provide automatic conversions of length, volume, area, or temperature between two different measuring systems, such as British and metric. Finally, the MM5765 programmer circuit, used in conjunction with any of the calculator chips, can provide computational programs of up to 102 steps.

All of the circuits in the new series feature automatic display cutoff to conserve battery power, trailing zero suppression, power-on clear, and a low battery signal display (when used with a suitable digit driver).

**Reader's Circuits.** Suitable for use in electronic music synthesizers, waveform generators, operational control sequencers, and similar projects, the circuits illustrated in Figs. 2 and 3 were submitted by reader Frank J. Canova, Jr. (725 Myrtle Ave., Green Cove Springs, FL 32043). Each circuit is capable of delivering a repetitive series of different output voltage levels when triggered by a chain of

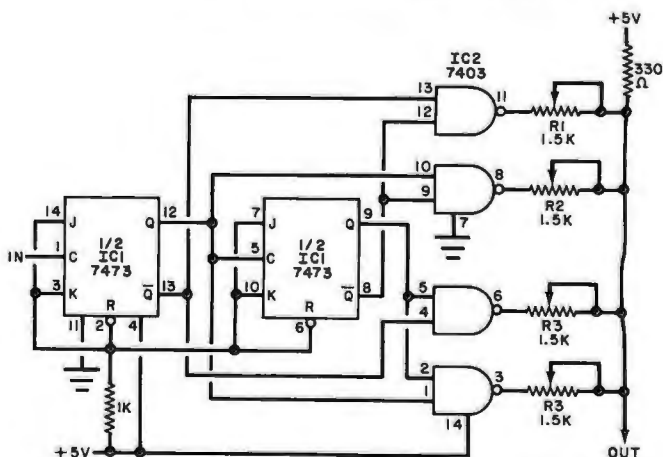


Fig. 2. Circuit provides four output voltage levels.

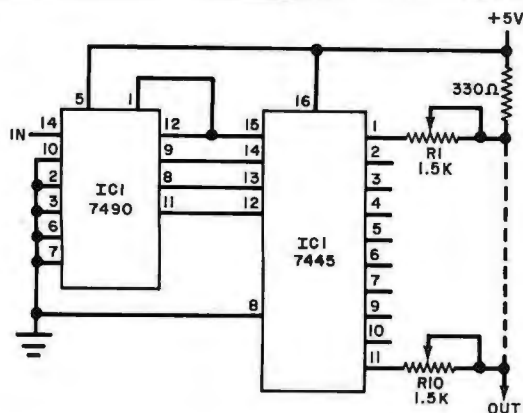


Fig. 3. Ten-step sequence or function generator.

pulse signals from a logic "clock" circuit or relaxation oscillator. Both circuits utilize readily available 7400 series digital logic IC's and both are designed for operation on standard 5-volt negative-ground dc sources.

As shown in Fig. 2, a 7473 dual J-K flip-flop, IC1, and 7403 quad 2-input positive NAND gate, IC2, are used to provide four output voltage levels in sequence when a pulse chain is applied to the circuit's input terminal. Each output voltage is preset (or programmed) by adjusting a potentiometer (R1 to R4) in series with one of the four NAND gate output terminals and the dc source voltage through a 330-ohm resistor. The flip-flops are inter-connected to form a binary counter.

The sequence starts with pins 8 and 13 of binary counter IC1 "high," driving only the top NAND gate on and shunting R1 to ground. At this point, the output voltage, established by the voltage division between the common 330-ohm resistor and R1, is somewhere between 0 and 4 volts (approximately), depending on R1's adjustment. When the first input pulse is applied, the input flip-flop changes state, with pin 12 (IC1) going "high," pin 13 "low." The top NAND gate is switched off, the second NAND gate on, and R2 is connected to ground, changing the output voltage to a level determined by R2. In a similar fashion, the next pulse causes both flip-flops to change state, with pins 13 and 9 of IC1 high and the third NAND gate switched on, all others off, and changing the output voltage to a level determined by R3. Finally, the fourth input pulse switches pin 12 (IC1) high, driving only the last NAND gate on and delivering an output voltage established by R4. The next pulse causes both flip-flops to change state and re-establishes the original conditions, starting a new cycle.

The circuit given in Fig. 3 operates in somewhat similar fashion, but utilizes a type 7490 decade counter and a type 7445 (or 74145) BCD-to-decimal decoder/driver to provide ten adjustable output levels. Again, separate potentiometers, R1 to R10, are used to establish each output voltage level.

Standard components are used in both designs. The potentiometers are 1500-ohm linear-taper types and can be either conventional knob-controlled units or screwdriver-adjusted trimmers, depending on the circuit's intended application. The fixed resistors are half-watt types. Any standard input and output connectors can be used, although shielded (coaxial) types are preferred. For optimum performance, the circuit(s) should be powered by

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a well-regulated 5-volt dc supply, with additional filtering provided on each circuit board to prevent possible cross-coupling. Frank recommends a 100- $\mu$ F electrolytic capacitor shunted by a 0.1- $\mu$ F plastic film or ceramic type, connected as close to the IC power terminals as is practicable.

Neither lead dress nor component layout are critical but soldering to the IC leads should be done with a 30-watt soldering pencil. Beginners may prefer to provide sockets for the IC's. Either pc or perf-board construction is satisfactory.

The completed circuit(s) can be used in any of a variety of applications, depending on the type of equipment involved and the frequency of the input drive signal, as well as upon the adjustment of the individual potentiometers determining the output voltage levels. If used with a music synthesizer, for example, the programmed output signal could serve to control vco (voltage controlled oscillator), vcf (voltage controlled filter), or gain circuits, or even a combination of these. The 10-step version (Fig. 3) is preferred for function generator applications. Here, the circuit can serve to create virtually any waveform that can be approximated by ten distinct voltage levels. As a general (but not inflexible rule) lower frequency drive signals are used in sequencer and music synthesizer applications, higher frequency signals up to the kHz and lower MHz range for waveform generation. An input drive signal of at least two volts amplitude is required for positive operation.

**R & D Tidbits.** While it may not be the ultimate answer to the nation's energy crisis, the semiconductor solar cell is certainly the simplest device currently available for converting sunlight into electricity. The chief limitations to its widespread use in the past have been its comparatively high cost and relatively low efficiency. However, both of these limitations may become less critical as the result of recent scientific breakthroughs, and the solar cell might well become a serious challenger in the energy race.

A new type of solar cell promising high efficiency at low cost has been developed by a research team at NASA's Jet Propulsion Laboratory in Pasadena, California. The new solar cell—dubbed AMOS, for Antireflection Coated Metal-Oxide-Semiconductor—is made from oxidized



gallium arsenide with an extremely thin, nearly transparent gold film on its surface. Some samples have demonstrated an efficiency of about 15 per cent in terrestrial sunlight, which is better than the average silicon solar cell now in standard use. Perhaps more important, the device is potentially adaptable to production using very low-cost polycrystalline film techniques, with only a modest reduction in efficiency.

Another breakthrough, also with gallium-arsenide photoelectric devices, has been made by a scientific team at Varian Associates, Palo Alto, CA. Using a concave reflector to concentrate the sunlight by a factor of 1000:1, the Varian Associates group has achieved an output of 10 watts from a solar cell measuring only 1 cm in diameter. This was made possible, in part, by gallium arsenide's ability to operate at high temperatures and high current densities beyond the reach of silicon devices. In addition, the Varian units have exhibited efficiencies as high as 23%, and Joe Feinstein, vice president of research at the firm, suggests that efficiencies as high as 35 to 40% may be possible within a few years.

In another area, scientists at Stanford University have been testing a new thick-film CMOS transducer capable of converting sound waves directly into electrical impulses which can be injected into an animal's auditory nerve system. The new transducer performs a function similar to that of the hair cells in the inner ear. Current tests are with cats' ears.

Engineers at the Bell Telephone Laboratories, Murray Hill, New Jersey, have designed and built the first solid-state TV camera that meets the resolution requirements for commercial broadcast use. The experimental camera, measuring only 2.5 x 2.5 x 6 inches, was built to demonstrate the feasibility of high resolution video-telephone systems. Its small size was made possible by the use of a solid-state charge-coupled device (CCD) as the imaging sensor. With an imaging area equivalent in size to the scanned area of a standard one-inch-diameter vacuum tube used in conventional TV cameras, the new CCD has 496 vertical interlaced scan lines and 475 horizontal picture elements and contains a quarter of a million sensing elements, representing a significant improvement in resolution over other known solid-state imaging devices.

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Finally, in fulfillment of another of the predictions made in last January's column, the LEAA (Federal Law Enforcement Assistance Administration) has contracted for the development of a *personal fitness monitor*—essentially a wristwatch-sized solid-state instrument that will instantly tell its wearer his pulse rate, temperature, blood pressure, and other critical information, with a built-in alarm to warn the user if his bodily signs have reached a dangerous level.

**Device/Product News.** In addition to its new calculator and programmer chips, discussed earlier, the National Semiconductor Corporation has recently introduced a number of other devices which should be of interest to serious experimenters, students, engineers, and hobbyists, including a new display driver, a 12-bit successive approximation register, and a new pair of line drivers.

Combining the best features of both CMOS and bipolar technologies, National's new display driver, the CD4511, incorporates a BCD decoder/driver and an integral latch on a single chip. The decoding functions and the latch are made with a CMOS process, which insures very low input current and power requirements. The output drivers, on the other hand, are constructed with a bipolar process, permitting the CD4511 to source segment currents of up to 25 mA. Logically, the device provides the functions of a 4-bit storage latch, a BCD-to-seven segment decoder, and seven high-current output drivers. Lamp test, blanking, and latch-enable inputs are provided for display testing, turning-off or brightness modulation, and storing the BCD code, respectively.

Designated type MM74C905, National's new CMOS 12-bit successive approximation register contains all of the digital control and storage necessary for building a 12-bit A/D (analog-to-digital) converter. Designed for operation over a supply range of from 3 to 15 volts, the device has a guaranteed noise margin of 1.0 volt. Provision is made for register expansion or truncation, and the circuit can function in either start/stop or continuous conversion modes, selectable by the user.

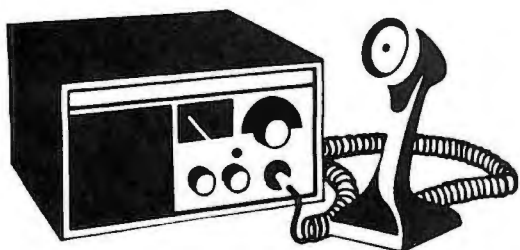
Manufactured using both CMOS and bipolar processes, National's new

line drivers, types MM88C29 and MM88C30, can operate on 3 to 15 volts, provide a noise immunity of (typically) 45% of the power supply, have an on resistance of only 20 ohms, and are capable of sourcing 80 mA (typ.). Both devices are offered in 14-pin Epoxy-B or ceramic DIP's. The MM88C30 is a dual differential line driver that also performs the dual four-input AND or the dual four-input NAND function.

An all-electronic solid-state tuning system designed primarily for TV sets has been developed by the General Instrument Corp. (New York, NY). Dubbed *Omega*, the new tuner features an MNOS nonvolatile memory, a CMOS D/A converter, and ion-implanted logic. It is approximately one quarter the size of corresponding electromechanical tuners. In operation, a metal-nitride-oxide semiconductor (MNOS) memory digitally stores all the tuning information needed for each TV channel, retaining the memory for up to 10 years, even with power removed. When the operator selects a station, information in the MNOS memory for that channel is coupled to a 14-bit CMOS D/A converter, developing a corresponding analog voltage, which can then be applied to a Varactor diode to tune in the selected station.

Two new npn power transistors, types 2N6465 and 2N6466, have been announced by RCA's Solid State Division (Box 3200, Somerville, NJ 08876). The new devices are complements of pnp types 2N6467 and 2N6468, respectively, and, as such, are useful in complementary-symmetry circuits for audio-frequency linear amplifier applications, as well as in linear modulators, servo amplifiers, and operational amplifiers. The 2N6465 is a 100-volt, 40-watt device with a dc beta of 15-150 measured at 1.5 A collector current, while the 2N6466 offers the same dissipation rating and beta range, but at 120 volts. Both types normally are supplied in hermetic JEDEC type TO-66 packages.

**Correction.** In our September column, we erroneously listed a 416-page Data-book from Unitrode as being free for the asking to anyone who wishes to obtain a copy. This book is available only to Unitrode's customer list as recommended by the company's Sales and Representative Staffs. We sincerely regret any inconvenience our error has caused. ♦



# CB Scene

By Len Buckwalter, K10DH

## SPEECH PROCESSING

**I**F YOU make the rounds at a CB coffee break or jamboree, chances are you'll hear conversations about "speech processing" and how it can improve communication intelligibility. Let's examine what it is and what it can do for you.

**Voice Signals.** Speech processing changes the characteristics of a voice

signal generated by a microphone. Observe that the signal shown in Fig. 1A is sharp, intermittent and non-repetitive. Moreover, there is a large difference between the average and peak values of the waveform. This is also true of the complex signal we get when the signal modulates an r-f carrier (Fig. 1B).

The desired result of the whole

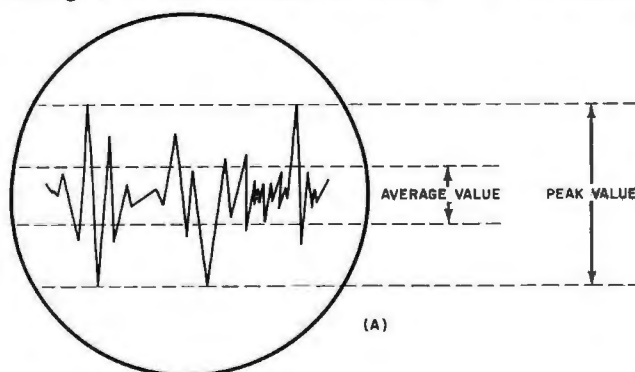


Fig. 1. At (A) is a typical voice signal. Voice peaks are high, but average level of speech is low. At (B) the signal modulates a carrier and the result has strong peaks but a low average modulation level.

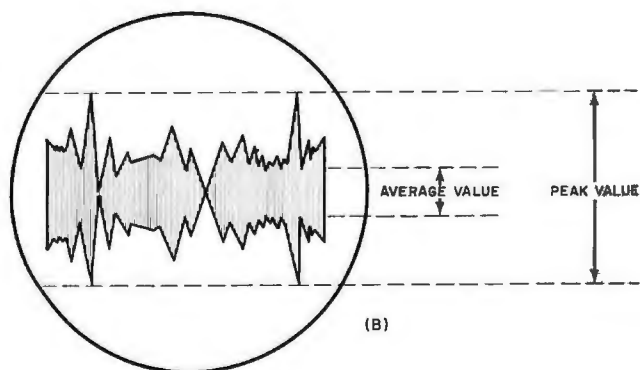
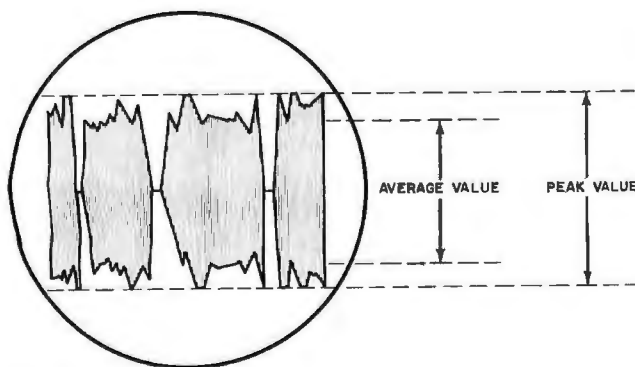


Fig. 2. In over-modulated signal, mike gain increases average level of signal but peaks have been clipped.



process—intelligibility—is dependent on the average power output of the transmitter. Typically, human speech that is fully modulating the carrier on, voice peaks will only produce 30% of the peak power most of the time. Thus, the ratio of the average power to the peak power is about 1 to 3. What we end up with is a carrier that loafers along, carrying much less intelligence than it actually could.

If we could find a way of increasing this average/peak ratio, our signal would become a lot more readable.

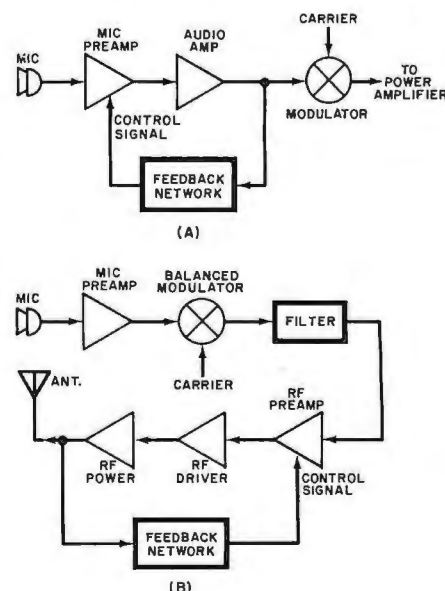


Fig. 3. Two methods of compression: audio and r-f.

One simple way to do this is to crank up the audio gain control. The resulting signal is shown in Fig. 2. Although the average value is a lot closer to the peak, the tops of the waveform are clipped off because the transmitter can't deliver the additional power required. Also, the carrier is interrupted on negative voice peaks. These result in "splatter" onto other channels and poor intelligibility on the desired one. "More modulation means a better signal," is only true when talking about modulation percentages up to the optimum of 100%. Trying to load more information onto the carrier than it can handle causes interference to other CB signals, TV receivers, etc. Also, it's illegal!

Speech processing, however, can increase the average power of the modulated signal without generating a clipped and interrupted wave. There are four basic types that we'll consider: audio compression, audio clipping, r-f compression, and r-f clipping. Each deals with the problem in differ-



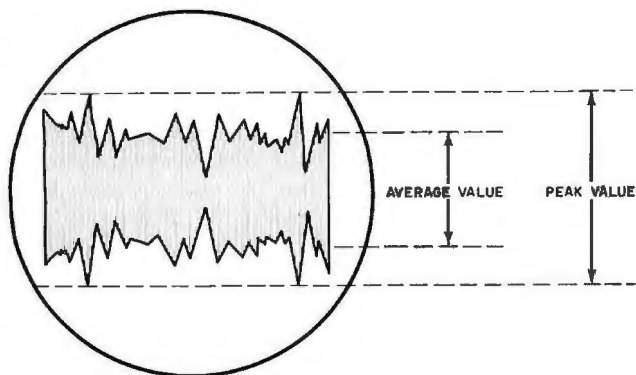


Fig. 4. In compressed modulated waveform, average signal level is high but peaks are compressed to avoid clipping.

ent ways. Predictably, each has advantages, disadvantages, and a varying degree of effectiveness.

**Compression.** One way of increasing the average degree of modulation is to use a "flexible" amplifier. That is, one with a lot of gain for weak signals, but very little for strong ones. These circuits have been around for a long time, and often assume the alias "automatic gain control" or simply agc. There are two methods of compression: audio and r-f, as shown in Fig. 3.

An audio compression system (Fig. 3A) works on the signal that comes straight from the microphone. This signal is amplified by the MIC PREAMP, and in turn by the AUDIO AMP. As the amplified version appears at the output of the AUDIO AMP, a small portion gets routed into the FEEDBACK NETWORK. In this stage, the sampled signal is rectified and filtered into a dc control voltage, which in turn determines the gain of the MIC PREAMP. When a strong signal appears at the AUDIO AMP output, a high dc level appears at the CONTROL SIGNAL input of the MIC PREAMP, cutting down its gain.

Sounds like a dog chasing its tail, doesn't it? In this case, however, the FEEDBACK NETWORK works fast enough

to control the PREAMP gain while the strong (or weak) signal is still going through it.

A weak signal into the MIC PREAMP will generate a small control voltage, providing lots of amplification. Accordingly, the average level of the modulating waveform will be increased; and, consequently, the carrier will be more fully modulated most of the time (Fig. 4).

A similar compression system operates on the modulated waveform, as shown in Fig. 3B. The r-f compressor (in this case, installed in an SSB transceiver) controls the gain of the r-f amplifiers by sampling a portion of the POWER AMP's output. The FEEDBACK NETWORK converts the r-f sample into a dc control voltage, which determines the gain of the R-F PREAMP. The same type of compression action occurs as in the audio system. The output signal would look like the one in Fig. 4.

**Clipping.** Another approach to speech processing is clipping, which is performed on either audio or r-f signals. In an audio clipper (Fig. 5A), the mike output is amplified by the MIC PREAMP, and filtered by the low-pass filter. Any audio frequencies above 3000 Hz are shunted to ground, since they don't carry useful information

and could cause problems. The AUDIO AMP then boosts the signal, and its output drives the AUDIO CLIPPER.

If we compare the output from this stage with Fig. 2, we would see almost the same waveform. This occurs because in most systems the clipper is really an amplifier running wide open. So the signal peaks get clipped off since they're too strong to be reproduced by the amplifier. But wait a minute—didn't the clipping action of Fig. 2 also imply splatter, harmonic radiation, etc.? Yes, but in this case we smooth the waveform by filtering out the audio highs, and then follow up the clipper with another LOW PASS FILTER. This rounds off the clipped corners of the signal, making it much more tolerable. Finally, an AUDIO AMP makes up for filter loss, and drives the modulator as in a conventional system. The output of the AUDIO AMP is shown in Fig. 6. The average value is close to the peak value, and signal peaks are smoothed out.

Clipping can also be accomplished in the r-f portion of a transmitter. Figure 5B shows the processing chain in a typical SSB transmitter. The MIC PREAMP boosts the modulating signal from the microphone. An audio LOW PASS FILTER eliminates highs, and the filtered waveform is boosted again by an AUDIO AMP. Then, the audio signal is combined with a carrier by the BALANCED MODULATOR, and a double sideband, suppressed carrier signal appears at the output. Since we need only one sideband, the FILTER eliminates the undesired one (upper or lower, depending on our preference).

Now we have a single sideband signal, albeit a weak one. The R-F PREAMP gives it a shot in the arm, and an R-F CLIPPER amplifies the signal so much that the tops get closed. As we mentioned before, the sharp corners of a clipped waveform contain many harmonics, so an r-f LOW PASS FILTER shunts the offending components to ground, and smooths out the signal. Finally, an R-F DRIVER adds signal gain to drive the power amp. The resulting waveform is shown in Fig. 6. Again, note that the average/peak ratio is a lot better, and the sharp edges are smoothed out.

**Which Is Best?** We've examined four methods of speech processing, and all appear to perform the desired function. The average level of modulation is greatly increased, but no spurious

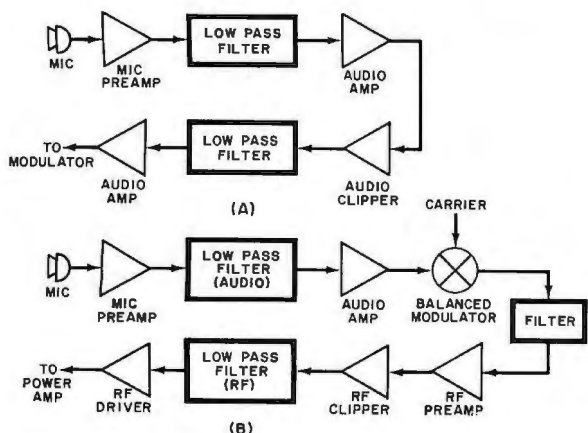


Fig. 5. At (A) audio clipper shapes voice waveform before modulation. R-f clipping (B) processes modulated signal and requires shielding and filter.

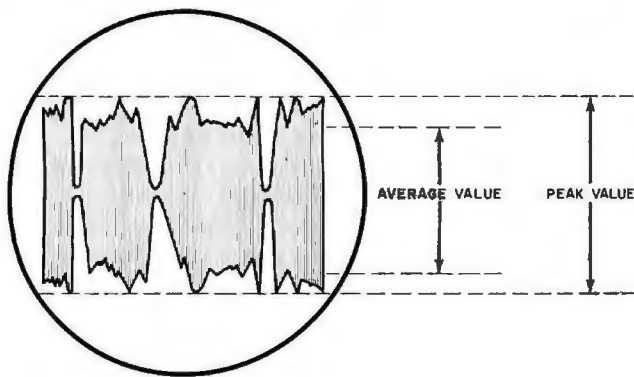


Fig. 6. A clipped and shaped waveform. Average modulation levels are higher, but filtering eliminates splatter.

signals are generated. But which system is best to use, in terms of ease of construction and/or installation, and degree of effectiveness?

In general, audio systems are easier to use, because they work with the existing transmitter circuitry. We can build an audio compressor or clipper in a small box, plug the mike into it and run a cable from the processor output to the mike jack on the transceiver. Audio compressors are simpler to build than clippers, since they don't require filtering stages. R-f systems, on the other hand, have to be inserted at a point within the r-f circuitry of the transceiver, thus requiring some "surgery." In general, r-f clippers are more complex and expensive than compressors, because of the strict filtering requirements.

But in terms of what the CB'er wants most, increased "talk power," r-f systems are superior to audio ones. For a given amount of speech processing, say 20 dB, r-f clipping will increase the signal-to-noise ratio at the receiver by 8 dB (over one S unit). Audio clipping will improve the S/N by about 5 dB, or just under one S unit. Audio and r-f compression will both give an S/N about one dB better than an unprocessed signal.

**Transmitter Requirements.** In order to get the most out of a speech processor, the transmitter must be designed along certain guidelines. Most important of these concerns the type of tubes or transistors used in the driver and power amplifier stages. Since the average modulation level is a lot higher, these devices will be handling much more power most of the time. This means they'll run hotter, and must be able to dissipate the extra heat generated. Otherwise, thermal effects will reduce their useful lifetimes.

Further, the power supply that supports these active devices must be

"stiff," since the average power demand will be a lot higher. This means that larger filter capacitors, higher-current rectifiers and voltage regulators must be used. Some compact chassis may require a cooling fan to move more air around heat-generating components. And, of course, inboard clippers will necessitate the use of stringent filtering and shielding techniques.

All this adds to the cost of producing a CB rig. Is it worth it? From on-the-air listening experience, speech compressors can do an impressive job of boosting signal readability. An 8-dB (6.3 times) signal boost can make that marginal contact a solid one!

**Intelligibility.** But copying a message easily is not just a question of signal levels. How clean the received signal is can be just as important. If we compare the original modulating signal (Fig. 1A) to the unprocessed, modulated carrier (Fig. 1B), we can see that the envelope of the waveform is a good replica of the voice signal. The processed signals (Figs. 4 and 6) contain envelopes which are distortions of the original. Inevitably, any speech processing introduces a certain amount of distortion. In most cases though, you'll find that the processed version is still quite recognizable—and more intelligible—than the original.

Most speech processors available to CB'ers are audio compressors—whether they are built-in, add-on accessories, or packaged inside an optional microphone. As we've already seen, clipping is more effective, especially when the r-f method is used. As more and more CB'ers learn of the advantages of speech processing, more effective methods will be included in new transceivers. It's a safe bet that you'll hear an increasing number of properly clipped signals on the air! ♦

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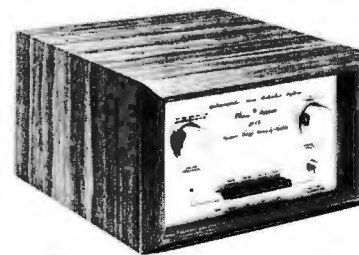
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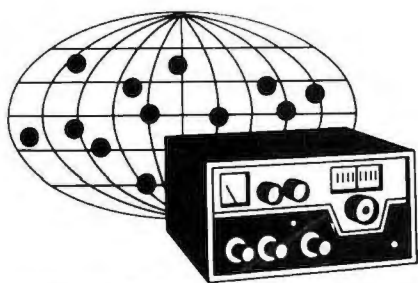
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# DX Listening

By Glenn Hauser

## WHAT TO LOOK FOR IN A SHORTWAVE RECEIVER

IT'S not too early to start hinting for a new shortwave receiver for Christmas. But unless you pick it out yourself, you may be disappointed. Choosing the best receiver is rather involved. You must know what to look for and how important certain features will be to you.

If you're just starting in DX listening, and not sure how deeply you want to get involved, you may prefer a low-priced portable, to get a feel for what it's all about. The trouble is, the portable may turn you off—unless you realize that most of the problems you have with it can be eliminated with a more expensive receiver.

**Image rejection** is a common problem in receivers with only one i-f stage. It's possible to be tuned to a station on a desired frequency and also simultaneously pick up both that station and an interloper on another frequency. This interfering "image" signal will be found at a frequency displaced above or below the desired frequency by an amount equal to twice the receiver's i-f. Hence, if you're simultaneously receiving 14-MHz Amateur transmissions and 15-MHz broadcasts, your 455-kHz i-f receiver can't sort out the two signals spaced 910 kHz apart. To minimize such problems, it's best to get a dual- or triple-conversion receiver right at the beginning.

Crowded dials cause frustration. Unless a receiver has adequate **bandspread**, you'll end up sweeping past a host of stations as soon as you touch the tuning dial. But a well-designed receiver with 1-kHz calibration marks spaced  $\frac{1}{8}$ " apart can be a joy to operate. It will allow you to easily home in on a rare station with a high degree of accuracy. Best, but costly,

are the digital frequency synthesizer receivers.

**Selectivity** is one of the most important characteristics of a good receiver. On better receivers, you can select different bandwidths as required; but lacking this feature, can you separate two strong signals only 5 kHz apart?

**Sensitivity** is an important consideration, too. Although it's great to have a receiver that can respond to signal levels of a fraction of a microvolt, such sensitivity is useless if masked by receiver-generated noise. An S/N ratio of at least 10 dB is acceptable.

If you want to copy SSB and CW signals, a *bfo* and *product detector* are essential. They also allow you to accurately determine the frequency of AM carriers (by tuning for zero beat).

If you live in an electrically noisy area and/or listen to especially noisy signals, a *noise limiter*—better still, a *noise blanker*—will make broadcasts intelligible.

**To Buy or Not to Buy.** In some cases, the deficiencies of your present receiver can be compensated for with an add-on accessory. For example, you can boost sensitivity by placing a properly designed FET or IC preamplifier between the antenna lead-in and receiver. A Q multiplier can add selectivity, as can an audio filter and/or an antenna tuner. The antenna tuner is particularly helpful in improving the selectivity of the front end. A crystal-controlled converter can eliminate image problems.

In short, sometimes it's not justified to buy a whole new receiver. In some cases, however, buying a new receiver is unavoidable. Poor mechanical and/or electrical stability, crowded

tuning dials, and a wobbly tuning mechanism demand extensive work beyond the capability of many DX'ers.

**Where and What to Buy.** We would all like to have a state-of-the-art receiver. But most of us simply can't afford to make a large investment for one of these receivers. What then is a realistic alternative?

There are a handful of fine new SW and general-coverage receivers around that range in price from about \$160 to \$600. The lower in price you go, the less you get in reception and general handling ability. Too, you might consider a used communication receiver that's in good condition. Many have crystal or mechanical filters, concentric tuning mechanisms, notch filters, and rock-solid construction, among other features. Their most desirable attribute is low price, and many of them—especially military surplus receivers—can be obtained for a fraction of their original cost.

If you're looking for one of these receivers, check the ads in amateur radio magazines. Surplus dealers and amateur radio supply houses in your area are also worth a visit. Two points are worth remembering, however. First, try to simulate your actual receiving conditions as close as possible. The best way to do this is to arrange to take the receiver home for a trial period—if the owner agrees.

Among the SW receivers currently used by DX'ers actively reporting to major clubs are the Hammarlund HQ180, HQ145, HQ160, and SP-600; R390 series of military receivers; and Drake SPR4, SW4, and R4B. Some are Amateur-band-only receivers and require additional local oscillator crystals. Others are for SW and broadcast-band only reception. The latter cover the major international bands (13, 16, 19, etc., meters), but they can't be used out-of-band where some rare catches lurk.

**Swan On the Air Again.** Last summer, Jack Jones in Jackson, Miss., discovered a new Honduran station calling itself "Radio Swan de Honduras" on 6185 kHz. The station takes an anti-communist line and operates 24 hours a day. The mailing address is in San Pedro Sula.

**The Brazilian Shuffle.** This is not a new dance, but a complicated new set of frequency assignments in the tropical bands—perhaps to show rural sta-



tions the central government is still boss, or just to confuse DX listeners! Here are the changes so far uncovered, thanks to monitoring in Brazil by Jack Perolo, Robert Veltmeijer and Cláudio Moraes, and in Paraguay by Tony Jones. Throw out your old lists, and go by this one when DX'ing Brazil. Best times are 0800-0900 GMT, and sunset to 0200. R=Radio; D=Difusora; CI=Clube; Cu=Cultura.

kHz		
New	Old	Station
2420	2410	R São Carlos
2424	2420	R Carajá
3205	3265	R Ribeirão Preto
3225	4935	Lins RCI
3235	3255	RCI Marília
3245	4825	RCI Varginha
3255	3355	RD Uberlândia
3255	3305	R Educadora Cariri
3265	4885	RCu Poços de Caldas
3285	3385	RCI Teresina
3287	3375	R Olinda
3305	3283	RCI Fluminense
3325	3315	R Gazeta Alagoas
3335	3345	R Alvorada Londrina
3345	3295	R Educadora Uberlândia
3365	4825	R Educadora Parnaíba
3365	4915	RCu Araraquara
3385	4795	R Congonhas
4756	3295	R Ed. Rural Campo Grande
4765	5035	R Espírito Santo
4775	4985	A Voz do Oeste
4785	4755	R Brasil Campinas
4790v	5025	RD Aquidauana (varies to 4795)
4808v	4805	RD Amazonas
4815	3365	RD Paraná/Londrina
4825	4815	RD Petrópolis
4825	4945	R Ed. Bragança
4835	4845	RD Teresina
4855	4865	RCI do Pará
4865	4765	R Sociedade Feira de Santana

4915	5035	R Anhanguera
4925	4855	RD Taubaté
4935	4945	R Capixaba
4935	4945	RD Mearim
4945	5015	RD Poços de Caldas
4945	5025	Voz de São Francisco
4965	4835	R Sociedade Triângulo Mineiro
4965	4937	R Poti
4985½	4995	R Brasil Central
5015	5055	RCu de Cuiabá
5015	4975	R Copacabana
5015	4880	R Pioneira
5025	3325	R Borborema
5025	5055	R Vitória
5035	4985	R Aparecida
5045	3335	R Presidente Prudente

This list does not include some stations on the same and other frequencies, which have not moved.

**More on RCI.** Radio Canada International is solving its QSL versus programming problem by disbanding its shortwave club, dropping DX and mailbag shows after November 1. The new requirement is that QSL seekers fill in details themselves, starting next spring.

**Change of Address.** When the Executive Editor of the International Radio Club of America, Fr. Jack Pejza, was transferred to a new assignment, ending the club's San Diego HQ, a new group in Seattle stepped forward to keep the club in business. IRCA's new address is Box 21462, Seattle, WA 98111. Samples of the 34-issue-per-year *DX Monitor*, covering all aspects of DX'ing the mediumwave (AM) band, are 50¢ each. ♦

## ENGLISH-LANGUAGE SHORTWAVE BROADCASTS FOR NOV. THRU FEB. by Richard E. Wood

### TO EASTERN NORTH AMERICA

TIME-EST	TIME-GMT	STATION	QUAL*	FREQUENCIES, MHz
6:00-7:30 a.m.	1100-1230	London, England	G	5.990 (via Sackville), 15.07
6:00-6:30 a.m.	1100-1130	Tirana, Albania	F	9.48, 11.985
6:00-9:00 a.m.	1100-1400	**VoA, Washington, U.S.A.	G	5.955, 9.73
6:15-7:15 a.m.	1115-1215	Montreal, Canada	G	5.97
6:15-7:45 a.m.	1115-1245	Melbourne, Australia	G	9.58
7:00-7:55 a.m.	1200-1255	Peking, China	F	11.685
7:30-8:30 a.m.	1230-1330	London, England	G	15.07
7:15-10:00 a.m.	1215-1500	HCJB, Quito, Ecuador	G	11.74, 15.115
7:30-8:00 a.m.	1230-1300	Stockholm, Sweden	G	17.71
8:15-8:45 a.m.	1315-1345	Berne, Switzerland	G	15.14
9:00-9:30 a.m.	1400-1430	Stockholm, Sweden	G	17.71
		Oslo, Norway	F	17.795 (Sun. only)
		Helsinki, Finland	G	15.185
10:00-11:15 a.m.	1500-1615	London, England	G	17.84 (via Ascension)
10:00-11:30 a.m.	1500-1630	HCJB, Quito, Ecuador	G	11.74, 15.115, 17.88

## CB where the ACTION'S at

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4:15-5:45 p.m.	2115-2245	London, England	G	5.975, 9.58, 11.75, 15.26 (via Ascension)
4:30-5:50 p.m.	2130-2250	Hilversum, Holland	G	5.965, 9.715 (Sun.: Dutch)
5:00-5:30 p.m.	2200-2230	Oslo, Norway	P	6.18 (Sun. only)
5:30-6:20 p.m.	2230-2320	Johannesburg, South Africa	G	9.525, 11.90, 11.97, 15.155
5:45-10:30 p.m.	2245-0330	London, England	G	5.975, 7.325, 9.58, 15.26 (last two via Ascension)
5:55-6:15 p.m.	2255-2315	Brussels, Belgium	F	9.73
6:00-6:30 p.m.	2300-2330	Stockholm, Sweden	F	6.035, 9.605, 11.705
6:00-7:30 p.m.	2300-0030	Moscow, U.S.S.R.	G	7.105, 7.15, 7.165, 7.205, 7.355, 7.39, 9.665, 12.05
6:45-7:45 p.m.	2345-0045	Tokyo, Japan	F	11.725, 15.27
7:00-7:30 p.m.	0000-0030	Tirana, Albania	G	7.065, 9.78
7:00-7:55 p.m.	0000-0055	Oslo, Norway	F	6.18, 9.645 (Sun.)
7:00-9:00 p.m.	0000-0200	Peking, China	F	9.94, 11.945, 15.06, 15.52, 17.673
7:30-8:00 p.m.	0030-0100	Sofia, Bulgaria	F	9.70
		**VoA, Washington, U.S.A.	G	6.13, 9.65, 11.71, 15.205
		Kiev, U.S.S.R.	G	7.15, 7.205, 9.685 (Mon./Thu./Sat.)
		Vilnius, U.S.S.R.	F	7.32, 7.355 (Fri./Sat.)
7:40-8:00 p.m.	0040-0100	HCJB, Quito, Ecuador	G	5.97, 9.56
8:00-8:15 p.m.	0100-0115	Brussels, Belgium	G	6.08
8:00-8:20 p.m.	0100-0120	Vatican City	G	5.995, 6.165, 9.605
8:00-8:45 p.m.	0100-0145	Rome, Italy	G	6.01, 9.575
		Berlin, Ger. Dem. Rep.	P	9.73
8:00-8:55 p.m.	0100-0155	Madrid, Spain	G	6.065, 11.925
		Peking, China	G	7.12, 9.78 (via Tirana), 11.685, 11.945, 11.965, 15.06, 15.52
8:00 p.m.-2:00 a.m.	0100-0700	Prague, Czechoslovakia	G	5.93, 7.345, 9.54, 11.99
		HCJB, Quito, Ecuador	G	5.97, 9.56, 11.915 (includes some Eskimo)
8:00-9:00 p.m.	0100-0200	Montreal, Canada	G	6.085
		Moscow, U.S.S.R.	G	7.105, 7.15, 7.165, 7.205, 7.355, 9.665, 9.70 (via Sofia), 11.86, 12.05
8:30-8:50 p.m.	0130-0150	Cologne, Ger. Fed. Rep.	G	6.01, 6.04, 6.10 (via Malta), 9.565, 9.69, 9.745, 11.865 (via Malta)
8:30-8:55 p.m.	0130-0155	Tirana, Albania	G	6.20, 7.30
		Vienna, Austria	P	6.155, 9.77
8:30-9:25 p.m.	0130-0225	Bucharest, Rumania	F	5.99, 9.57, 9.68, 11.775, 11.94
8:45-9:15 p.m.	0145-0215	Berne, Switzerland	G	5.965, 6.12, 9.535, 11.715
9:00-9:30 p.m.	0200-0230	Budapest, Hungary	F	6.00, 7.22, 9.833, 11.91 (except Sun.)
		Oslo, Norway	F	6.18, 9.645 (Sun.)
9:00-9:55 p.m.	0200-0255	Lisbon, Portugal	F	6.025, 11.935
9:00-10:00 p.m.	0200-0300	Peking, China	F	11.965, 12.055, 15.06
		Moscow, U.S.S.R.	G	7.105, 7.165, 7.205, 7.355, 9.61, 9.665, 9.70 (via Sofia), 11.86, 12.05
9:00-10:20 p.m.	0200-0320	Hilversum, Holland	G	6.165 (via Bonaire)
9:00-10:30 p.m.	0200-0330	Cairo, Egypt	G	9.475
9:00-11:00 p.m.	0200-0400	Warsaw, Poland	P	6.095, 6.135, 7.27, 9.675, 11.815 (mixed Polish/English)
9:30-10:00 p.m.	0230-0300	Beirut, Lebanon	P	9.675
10:00-10:30 p.m.	0300-0330	Budapest, Hungary	F	6.00, 7.22, 9.833, 11.91
		Helsinki, Finland	P	9.55
10:00-11:00 p.m.	0300-0400	Buenos Aires, Argentina	G	9.69 (Mon.-Fri.)
		Peking, China	G	7.12, 9.78 (via Tirana)
		Prague, Czechoslovakia	G	5.93, 7.345, 9.54, 11.99
		Moscow, U.S.S.R.	G	7.15, 7.165, 7.205, 7.355, 9.70 (via Sofia)
10:30-10:55 p.m.	0330-0355	Tirana, Albania	G	6.20, 7.30
		Vienna, Austria	P	6.155, 9.77
10:30-11:00 p.m.	0330-0400	Kiev, U.S.S.R.	G	7.205, 7.39, 9.685 (Mon./Thu./Sat.)
10:30-11:30 p.m.	0330-0430	London, England	G	5.975, 9.58 (via Ascension)
10:30 p.m.-1:00 a.m.	0330-0600	Havana, Cuba	G	11.76
11:00-11:25 p.m.	0400-0425	Bucharest, Rumania	F	5.99, 9.57, 9.68, 11.775, 11.94
11:00 p.m.-1:00 a.m.	0400-0600	Moscow, U.S.S.R.	G	7.15, 7.165, 7.205, 7.355, 9.665
12 mid.-12:15 a.m.	0500-0515	Jerusalem, Israel	G	5.90, 7.395, 9.009, 9.815
1:00-1:30 a.m.	0600-0630	Oslo, Norway	F	6.18 (Mon.)

### TO WESTERN NORTH AMERICA

TIME-PST	TIME-GMT	STATION	QUAL*	FREQUENCIES, MHz
3:00-4:30 a.m.	1100-1230	London, England	G	5.99 (via Sackville),
4:15-5:15 a.m.	1215-1315	London, England	F	11.75 (via Tebrau)
4:15-7:00 a.m.	1215-1500	HCJB, Quito, Ecuador	G	11.74, 15.115

5:00-5:15 a.m.	1300-1315	Tokyo, Japan	G	5.99
5:00-8:00 a.m.	1300-1600	**VoA, Washington, U.S.A.	G	6.11, 9.76, 11.715
6:00-6:30 a.m.	1400-1430	Tokyo, Japan	G	5.99
7:00-7:30 a.m.	1500-1530	Tokyo, Japan	G	5.99
7:00-8:30 a.m.	1500-1630	HCJB, Quito, Ecuador	G	11.74, 15.115, 17.88
8:00-8:30 a.m.	1600-1630	Oslo, Norway	F	15.345 (Sun.)
8:00-9:15 a.m.	1600-1715	London, England	G	15.365 (via Sackville)
8:42-8:51 a.m.	1642-1651	Hilversum, Holland	G	15.14, 15.19 (via Bonaire; mixed English/Dutch)
9:00-9:15 a.m.	1700-1715	Tokyo, Japan	G	5.99
10:00-10:15 a.m.	1800-1815	Tokyo, Japan	G	5.99
11:00-11:15 a.m.	1900-1915	Tokyo, Japan	G	9.505
12 noon-12:15 p.m.	2000-2015	Tokyo, Japan	G	9.505
1:00-1:15 p.m.	2100-2115	Tokyo, Japan	G	9.505
1:15-3:00 p.m.	2115-2300	London, England	F	15.26 (via Ascension)
2:00-2:15 p.m.	2200-2215	Tokyo, Japan	G	15.105
3:00-3:30 p.m.	2300-2330	Tokyo, Japan	G	15.105
3:00-4:30 p.m.	2300-0030	London, England	G	6.175, 9.51 (via Sackville), 9.58, 15.26 (via Ascension)
4:00-4:15 p.m.	0000-0015	Tokyo, Japan	G	15.105
4:00-6:00 p.m.	0000-0200	**VoA, Washington, U.S.A.	G	9.545, 11.78, 15.25, 17.895
4:30-7:30 p.m.	0030-0330	London, England	G	6.175 (via Sackville), 9.51 (via Greenville), 9.58, 15.26 (via Ascension)
4:30-5:00 p.m.	0030-0100	HCJB, Quito, Ecuador	G	5.97, 9.56
5:00-5:15 p.m.	0100-0115	Tokyo, Japan	G	15.105
5:00-5:55 p.m.	0100-0155	Peking, China	G	11.945, 11.965, 12.055, 15.06, 15.52
5:00-7:00 p.m.	0100-0300	Melbourne, Australia	G	15.32, 17.795
		Moscow, U.S.S.R.	G	12.05, 15.18, 17.72, 17.87 (via Soviet Far East)
5:00-11:00 p.m.	0100-0700	HCJB, Quito, Ecuador	G	5.97, 9.56, 11.915 (includes some Eskimo)
5:30-6:30 p.m.	0130-0230	Tokyo, Japan	G	15.195, 15.235, 17.725, 17.825
6:00-6:15 p.m.	0200-0215	Tokyo, Japan	G	15.105
6:00-6:55 p.m.	0200-0255	Peking, China	G	11.455, 11.965, 12.055, 15.06, 17.855
6:00-7:50 p.m.	0200-0350	Taipei, Taiwan	F	11.86, 15.125, 17.72
6:30-7:00 p.m.	0230-0300	Stockholm, Sweden	F	9.695, 11.705
7:00-7:15 p.m.	0300-0315	Tokyo, Japan	G	15.105
7:00-7:30 p.m.	0300-0330	Seoul, Korea	P	15.335
7:00-7:45 p.m.	0300-0345	Madrid, Spain	P	6.065, 11.925
7:00-7:55 p.m.	0300-0355	Peking, China	G	7.12, 9.78 (via Tirana), 11.445, 12.055, 15.06, 15.385, 17.735, 17.855
7:30-8:15 p.m.	0330-0415	Berlin, Ger. Dem. Rep.	P	5.955, 6.08, 9.73
7:30-8:30 p.m.	0330-0430	London, England	G	6.175 (via Sackville)
				9.58 (via Ascension)
7:30-9:30 p.m.	0330-0530	Moscow, U.S.S.R.	G	5.98, 7.17, 7.265, 9.54, 9.58, 9.61, 9.735, 9.78, 11.69, 11.86, 15.14, 15.18, 17.755
8:00-8:15 p.m.	0400-0415	Tokyo, Japan	G	9.505
8:00-8:30 p.m.	0400-0430	Sofia, Bulgaria	F	9.70
		Budapest, Hungary	F	6.00, 7.22, 9.833, 11.91 (Tues., Fri.)
8:00-9:00 p.m.	0400-0500	Montreal, Canada	G	6.135, 9.655
8:30-9:00 p.m.	0430-0500	Lisbon, Portugal	F	6.025, 11.935
		Berne, Switzerland	F	6.045, 9.725
9:00-9:15 p.m.	0500-0515	Tokyo, Japan	G	9.505
		Jerusalem, Israel	F	5.90, 7.395, 9.815
9:00-10:00 p.m.	0500-0600	Montreal, Canada	G	6.135, 9.655
9:00-10:20 p.m.	0500-0620	Hilversum, Holland	G	6.165, 9.715 (via Bonaire)
9:30-9:50 p.m.	0530-0550	Cologne, Ger. Fed. Rep.	F	6.075, 6.185, 9.545
9:30-10:00 p.m.	0530-0600	Moscow, U.S.S.R.	G	5.98, 7.15, 7.17, 7.265, 9.54, 9.58, 9.61, 9.735, 9.78, 15.18
10:00-10:15 p.m.	0600-0615	Tokyo, Japan	G	9.505
10:00-10:30 p.m.	0600-0630	Oslo, Norway	F	9.645 (Sun.)
10:00-11:00 p.m.	0600-0700	Buenos Aires, Argentina	G	9.69 (Mon.-Fri.)
10:00-11:30 p.m.	0600-0730	Moscow, U.S.S.R.	G	5.98, 7.11, 7.15, 7.17, 7.265, 7.305, 9.54, 9.58, 9.61, 9.735, 9.78, 11.69, 15.18
10:30 p.m.-12 mdt.	0630-0800	Havana, Cuba	G	9.525
11:00-11:15 p.m.	0700-0715	Tokyo, Japan	G	9.505
12 mdt.-12:15 a.m.	0800-0815	Tokyo, Japan	G	9.505
1:00-1:15 a.m.	0900-0915	Tokyo, Japan	G	9.505
2:00-2:30 a.m.	1000-1030	Tokyo, Japan	G	5.99

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 \*\*Not intended for North America, but receivable satisfactorily

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**By Jerry Ogdin**

coded keyboard. These are frequently on the surplus market for less than \$25.00.

A terminal is important, but it is only one tool in the computer hobbyist's kit. Once you've written a program and gotten it into storage, you ought to use the cassette interface (HIT) described in September's column. With this tool, you have to "button in" the program bit-by-bit only once. After it is in storage, you can write it out to be taped

Also, if your only storage medium is RAM, you'll have to reenter the tape reading routine laboriously through the switches (or the terminal) each time the computer power is turned on. That is a good reason for having a small program, called a *bootstrap loader*, kept in read-only memory. This program makes it possible to read data from the tape and then execute that data. Such a read-in program is usually somewhat larger and more powerful, so it reads in several records (perhaps using the bootstrap program as a subroutine), which make up an even larger and more sophisticated program. The effect, then, is to use one group of records to read the next

```

3E20      MVI A, ' '
CD0301    CALL WRCHR
00A2: 0A    MORE: LDAX B      ;FETCH BYTE TO DUMP
1F        RAR
1F        RAR
1F        RAR
1F        RAR
CEDE00    CALL CVTAS      ;ISSUE MSB
0A        LDAX B
CEDE00    CALL CVTAS
3E20      MVI A, ' '
CD0301    CALL WRCHR
03        INX B          ;ACQUIRE NEXT CELL
C37700    JMP DUMP+3

; THIS ROUTINE READS ONE OR MORE HEXADECEMAL
; DIGIT CHARACTERS ('0'..'9', 'A'..'F') IN
; AND ACCUMULATES A SIXTEEN-BIT NUMBER IN
; THE (H,L). EACH NEW DIGIT IS SHIFTED INTO
; THE LEAST-SIGNIFICANT FOUR BITS OF THE (H,L).
; CONTROL IS RETURNED WHENEVER THE DEPENDENT
; ROUTINE ("RDHEX") SETS THE CARRY BIT TRUE.

00B7: 210000 RDNUM: LXI H,0      ;START OFF VALUE AT 0
CDD600     CALL RDHEX      ;GO GET A HEX DIGIT
DAB700     JC RDNUM        ;AWAIT HEX DIGIT

00C0: 29     RDNXT: DAD H      ;SHIFT (H,L) LEFT 4
29         DAD H
29         DAD H
29         DAD H
B5         ORA L          ;PLACE NEW FOUR BITS IN
6F         MOV L,A
CDD600     CALL RDHEX      ;GO GET NEXT DIGIT
D8         RC            ;THE NUMBER'S FINISHED
C3C000     JMP RDNXT       ;GO PROCESS NEXT DIGIT

; THIS ROUTINE READS A NUMBER VIA "RDNUM" AND
; PLACES IT INTO THE (B,C) PAIR

00CD: CDB700 RDNR2: CALL RDNUM    ;GET THE VALUE IN (H,L)
44         MOV B,H        ;THEN MOVE IT
4D         MOV C,L
C9         RET

; THIS ROUTINE READS IN AN ASCII CHARACTER,
; STRIPS OFF PARITY AND EXAMINES IT FOR
; MEMBERSHIP IN THE HEX-DIGIT SET. IF IT IS
; A HEX-DIGIT THE A-REGISTER IS LEFT AT THE FOUR
; BIT VALUE APPROPRIATE AND THE CARRY IS CLEARED.
; ANY OTHER CHARACTER IS LEFT UNTOUCHED AND THE
; CARRY IS SET.

00D3: D630   RDDIG: SUI '0'      ;TRANSLATE '0'..'9'
C9         RET
00D6: CD0001 RDHEX: CALL RDCHR   ;**ENTRY POINT**
E67F      ANI 07FH          ;REMOVE PARITY BIT
FE30      CPI '0'
D8        RC              ;CHAR LESS THAN '0' (NOT HEX)
FE3A      CPI '9'+1
DAD300    JC RDDIG        ;IN RANGE 0..9
FE41      CPI 'A'
D8        RC
FE47      CPI 'F'+1
3F        CMC
D8        RC              ;BETWEEN 9 AND A
D637      SUI 'A'-10
C9        RET            ;NOT HEX CHARACTER
;TRANSLATE 'A'..'F'

; THIS ROUTINE CONVERTS A BINARY NUMBER IN THE
; LEAST-SIGNIFICANT BITS OF THE A-REGISTER TO
; AN ASCII CHARACTER REPRESENTING THE HEX VALUE
; AND THEN ISSUES IT AS OUTPUT.

00ED: E60F   CVTAS: ANI 15      ;ISOLATE FOUR BITS
C630      ADI '0'          ;SHIFT DIGITS INTO ASCII
FE3A      CPI '9'+1        ;SEE IF IT WAS 0..9
DA0301    JC WRCHR
C607      ADI 'A'-'0'-10   ;CONVERT TO 'A'..'F'
C30301    JMP WRCHR

```

group in, thus "pulling" the program in by its own bootstraps.

**Using a Monitor.** The ability to preserve a program for later recall is important, but it doesn't solve two major nuisances: (1) you still have to key in the program bit-by-bit the first time; and (2) every time you make an error in the program, you have to key in the changes, some of which may be traumatic and complex. One of the best ways to solve this kind of inconvenience is to provide a small *monitor*. A monitor is just another computer program, but one that is designed to make computer use more convenient. This program reads characters from a terminal (or a separate keyboard), with these characters specifying the bit patterns to put into memory.

The simplest monitor has three basic *commands*: Load, Dump and Go. A command is a single letter typed at a time when the monitor is not otherwise engaged in some activity. Typical commands are single letters like "L" for Load, "D" for Dump and "G" for Go. When you type in "L" you are directing the monitor program to accept keyboard input and load it into memory; "D" means you want to display contents of memory on your terminal or display device; "G" is your means of transferring control out of the monitor into the program you have previously loaded.

Most programmers now use the hexadecimal number system for communicating with the machine, although there are "pockets" of users of octal. Hex and octal are, of course, just shorthand notations for binary code. Hex digits allow us to specify four bits with one symbol, octal allows three. The hexadecimal digits are 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, and F. (The letters A through F stand for decimal equivalent values 10 through 15, respectively.) The monitor, for utmost simplicity, uses only hexadecimal digits for the specification of addresses and data byte values.

Each of the command letters (L, D or G) is followed by an address that specifies where to start. For the Load command, that address is where the first byte of data from the keyboard will be stored; for Dump, it is the address from which data will begin being displayed; for Go, it is the address that is to be placed into the CPU's program counter. Whenever the Go command's address has been supplied, control is transferred to that

location. Whenever the Dump command's address has been given, data displaying will begin. However, after the Load command's address, the monitor will expect more bytes (one after another) to be loaded into successive locations in memory.

A small monitor for the 8080 microprocessor that you can use as a model is shown opposite. Each command is stopped by resetting the CPU, thus returning control to the top of the monitor. Notice some error correction conventions that have been instituted to save you some time: numbers are assumed to consist of any number of hex digits but if the monitor wants an address, only the least-significant four digits are used. Likewise, for a data byte, only the least-significant two hex digits are preserved. This means that if you've made an error, just keep typing. Hex digits end with any character that is not a hex digit; most people find that the space character is the most convenient.

**News Items.** The extremely popular 8080, originally from Intel, is now being supplied by other semiconductor makers as well. The TI TMS8080 is identical to the original 8080, which Intel no longer makes. Intel's newer device, the 8080A, is functionally identical but has better current drive capacity. Intel has another part, the 8080A-1, that'll go faster so that AMD's 9080 (which is supposed to run 50% faster than the original Intel part) will have a competitor. So, if you are using the 8080, be sure to check the diagrams to see that your part matches the requirements.

The new MOS Technology 6501 is destined to become a popular CPU among hobbyists, if only because of its dramatically low price (\$20 at press time). The device is modelled after Motorola's 6800, although with some major differences. All of the Motorola support parts like memory I/O chips can be used with the 6501, so you can get on board quickly. The Motorola software, however, cannot be executed on the 6501 without revision.

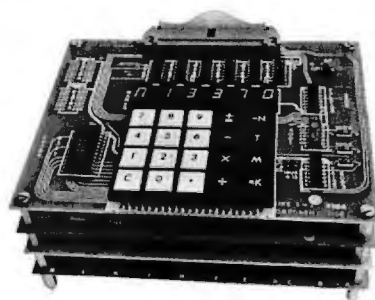
The 6501 is capable of operation at twice the Motorola part's speed; some parts may operate three times as fast. The introduction of this part is likely to start the real price war that has been brewing in the microprocessor business. Even with the new support chip for the 8008 that Intel has announced, it seems unlikely that it can compete with the 6501 for hobbyist use. ♦

## QUICK.... what number is this?



If you have to read your microcomputer like this—bit by bit, from rows of lights—the computer's making *you* do its work. And if you have to use rows of toggle switches to program it, you might wonder why they call the computer a labor-saving device!

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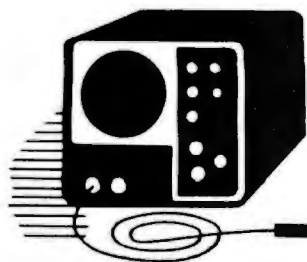
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# Test Equipment Scene

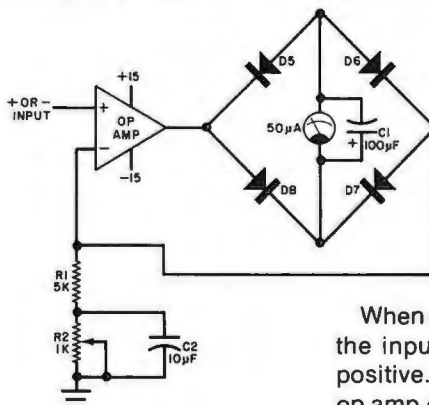
By Leslie Solomon

## A DUAL-POLARITY DC METER

**H**OW CAN you get a dc meter to indicate upscale with either a positive or negative input, without reversing the leads? It's very simple with an operational amplifier and a few other components as shown in the diagram.

The op amp is connected as a non-inverting dc amplifier using the diode full-wave bridge and the combination of  $R1$  and  $R2$  to determine the gain. Capacitor  $C2$  bypasses any ac component that might be across  $R2$ . The op amp can be almost any type with a high slew rate. For some op amps, frequency compensation may be required to remove any tendency for the op amp to oscillate at a high frequency, which would produce erratic meter indications.

Since the op amp is powered by a balanced  $+15\text{-V}$  and  $-15\text{-V}$  supply and the inverting ( $-$ ) input is refer-



enced to the common, a positive-going voltage on the input produces a positive voltage at the op amp output. Conversely, a negative-going input produces a negative output. The amplitude of either output is proportional to the level of the input voltage up to the  $15\text{-V}$  limit. The output is referenced to the common.

Obviously, if the input is zero, the output is zero. Actually, there is a very small switching area about the zero point where operation may be erratic; and there may also be a slight offset that can be removed by proper compensation as detailed in the op amp specifications.

When a positive voltage is applied at the input, the output starts to swing positive. Current then flows from the op amp output through  $D8$ , the meter,  $D6$ ,  $R1$ , and  $R2$  to ground. This current generates a positive voltage at the inverting input of the op amp. When it reaches the same level as the voltage on the noninverting input, the op amp stabilizes and the meter remains at some upscale indication (which can be adjusted by  $R2$ ).

When a negative voltage is applied to the noninverting input, the output of the op amp swings negative and the circuit is through  $R2$ ,  $R1$ ,  $D7$ ,  $M1$ , and  $D5$ . This current produces a negative voltage at the inverting input; and when it reaches the same value as that at the input, the op amp is stabilized. The meter once again settles at an upscale indication. In both cases, the current flows in the same direction through the meter.

Capacitor  $C1$  is used to smooth any voltage fluctuations across the meter—especially when the meter is measuring low-frequency ac. Such voltage integration removes flutter from the meter movement.

The voltage difference between the two inputs to the op amp is measured in millivolts so the positive-to-negative transition is very sharp. With some accurately known dc (either polarity) applied to the input,  $R2$  can be adjusted to give the correct indication on the meter.

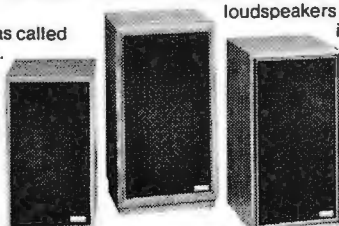
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# Hobby Scene

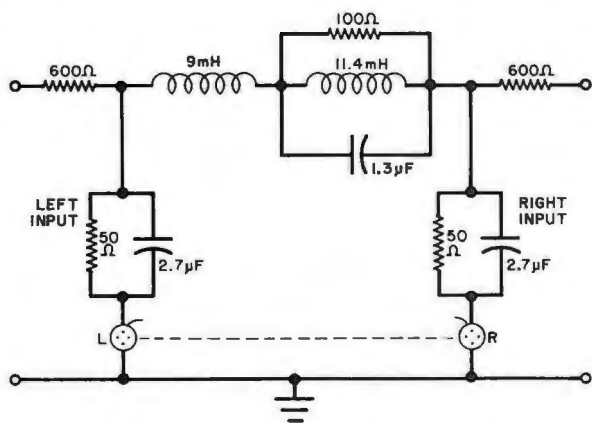
## "STEREO" HEADPHONE SOUND

**Q.** My stereo headphones don't sound "stereo", but rather like two separate sound sources. Why not? Can I build a circuit that will make them sound stereophonic?

—D. Whelan, Jersey City, NJ

**A.** "Stereo" headphones have two electrically and acoustically separate channels. Loudspeakers, on the other

hand, have a certain amount of acoustical "crosstalk" or blending between them. The circuit shown will electrically introduce the appropriate amount of crosstalk (in both amplitude and phase) to make the headphones sound "stereophonic" rather than "binaural". Be sure to use non-polarized capacitors. If you can't find the required values, use smaller capacitors, paralleling them until the desired capacitance is reached.

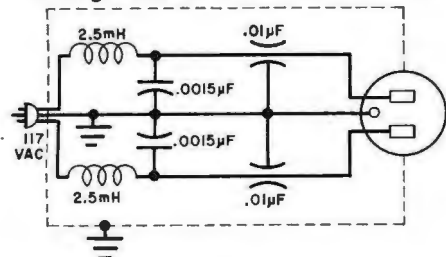


## FLUORESCENT LAMP FILTER

**Q.** Whenever I turn on both my AM radio and my fluorescent desk lamp, "hash" comes out of the speaker. Is there any way to eliminate this interference?

—D. Rigg, Southampton, NY

**A.** R-f coming from the lamp can get into the radio by direct radiation or through the ac line cord. The filter



shown, when constructed in a metal box connected to a good ground, will take care of r-f on the line cord. For lamps up to 35 W, use two Miller 6304 coils in parallel for the required 2.5-mH inductors. Bypass capacitors should be 500-WVDC disc ceramics,

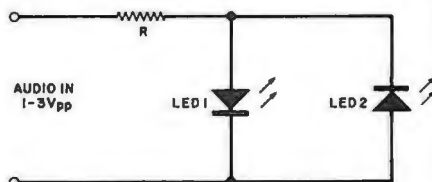
and the feedthrough capacitors should be Allen-Bradley CL003-HA503P units or equivalent. If the problem persists, it will be necessary to shield the lamp housing with fine-mesh screening. Ground both the screening and lamp base (if metal).

## LED ZERO BEAT DISPLAY

**Q.** Is there any visual means of detecting when I have "zero-beated" my vfo and a received signal?

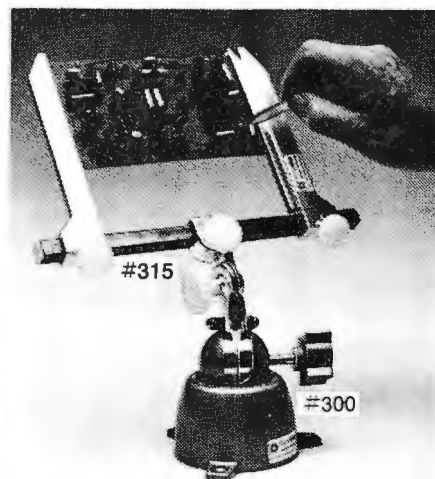
—M. Farber, Las Vegas, Nev.

**A.** If your receiver has an S meter, you can adjust for zero beat while watching its needle. As the two frequencies approach each other, the needle will swing back and forth more and more



slowly. At zero beat, the needle will hold one position. The circuit shown will also give a visual display of zero beat. When the vfo has come within 25 Hz of the signal's carrier, the LED's will alternately flicker. At zero beat, neither LED will light up. The circuit can also be used as a polarity checker for dc applications. When the top input terminal is positive, LED1 will glow, while LED2 turns on when the bottom input terminal is positive. Select R to limit LED current to a safe value, or use a voltage divider.

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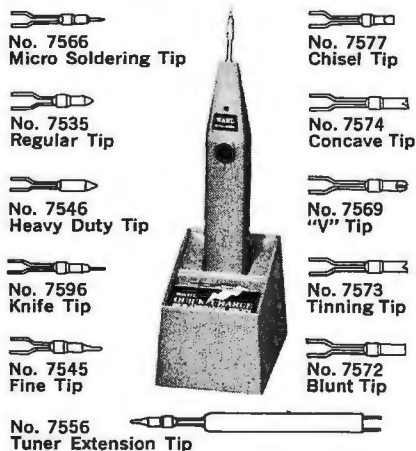
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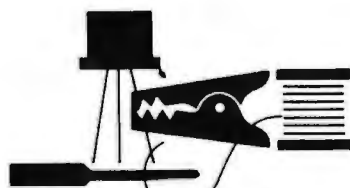
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## Tips & Techniques

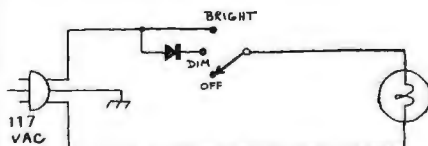
### Tracing Foil Patterns

Etching simple printed-circuit boards from pc blanks can be very easy if you use masking tape to trace the resist pattern. Cover the copper surface of the blank completely with broad masking tape, taking care not to overlap the tape or to leave gaps between each strip. Then trace the outline of the foil pattern on the etching and drilling guide, using a sheet of carbon paper between the tape and the guide. Carefully cut out the tape from the areas to be etched using a sharp knife or razor blade. Then apply the resist using the "stencil" made from the masking tape. When the etch resist is dry, score it with a razor blade where it touches the tape. After the remaining tape is removed, the board is ready to be etched.

—Anthony Barake, Quebec, Canada

### An Inexpensive Lamp Dimmer

If you want more than one light-level output from an incandescent bulb, this circuit is useful. What's more, it can lengthen bulb life considerably, while saving you money on electric bills and make expensive three-way bulbs and dimmers unnecessary. When the power switch is turned to the DIM position the diode allows only positive half-cycles of the ac power to flow

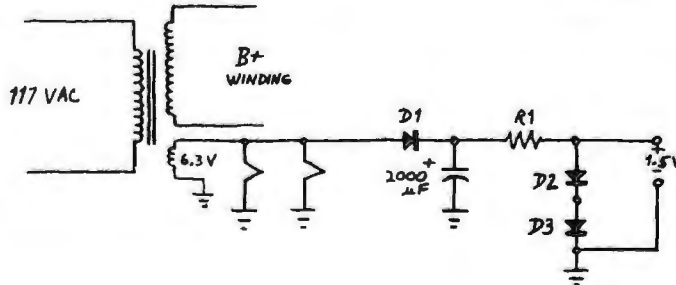


—Paul E. Griffith

### Battery Eliminator For VTVM'S

If you're tired of replacing the 1.5-volt battery in your VTVM, here's a simple circuit that will eliminate the need for the cell. Diode D1 rectifies the 6.3-V ac filament supply, and a 2000-μF capacitor smooths out the dc. Since the forward voltage drop across a silicon diode is about 0.7 V, connecting two of them in series from the dc supply to ground provides a voltage drop of nearly 1.5 volts. R1, a current-limiting resistor, is composed of two 68-ohm, 2-watt resistors in parallel. All diodes should be 500-mA, 50-PIV or greater units. The electrolytic capacitor ought to have a 15-WVDC rating.

—Donald Wallace, Appalachia, VA



through the bulb. In the BRIGHT position, the bulb behaves normally. Be sure to use an adequately rated diode (both PIV and forward current) for the power consumption (in watts) of the light bulb.

—Bill Drislane, Topsfield, MA

### IC Breadboards

Breadboarding IC projects is a common practice and many commercial boards are available. However, an inexpensive substitute can easily be made in a pinch. Using 0.1-in. (0.25-cm) grid P-pattern board as a template, drill holes in a piece of perforated board to accept the pins of a 14- or 16-pin DIP. Wire the pins to two rows of spring clips (Vector T-32A or similar). Place extra clips along board edges for use as tie-points. Install push-in flea clips at each corner to elevate the board. Several assemblies can be secured to a larger board for combining subsystems. A strip of masking tape along the terminals permits markings for pin numbers and functions to be made.

—Raymond F. Arthur, New Kensington, PA

### Home-Made Adapter Lets You Measure Dwell with Ohmmeter

To use an ohmmeter to measure a car's dwell time, a 1N34 or similar diode must be placed in series with the meter's "hot" test lead. The easiest way to install the diode is to house it in an adapter that can be quickly inserted into and removed from the test setup. This eliminates the need to modify the ohmmeter. To make the adapter, first slot a tip jack to accept the blade of a screwdriver. The next step is to enlarge the barrel of a standard short-barrelled test prod just enough to permit the tip jack to be screwed tightly into it. After prethreading the barrel, solder one lead of the diode to the tip jack (which lead depends on the polarities of the voltages at the meter's test jacks and the car's electrical ground). Use an insulated spacer and finish assembling the adapter.

—Paul E. Griffith

# Operation Assist

If you need information on outdated or rare equipment—a schematic, parts list, etc.—another reader might be able to assist. Simply send a postcard to Operation Assist, POPULAR ELECTRONICS, 1 Park Ave., New York, NY 10016. For those who can help readers, please respond directly to them. They'll appreciate it. (Only those items regarding equipment not available from normal sources are published.)

**Citi-Phone** Model Cd-5 CB transceiver. Tube layout, schematic, and/or service manual. Randy Venable, 2009 Princeton Ave., Bradenton, FL 33507.

**United Scientific Laboratories** Contact 23 CB transceiver. Schematic and/or service info. R. T. Henley, 139 Mardi Gras, El Paso, TX 79912.

**Precision** Model E-400 sweep generator. **Amp. Corp. of America** Model ACA-100DC PA amplifier. **Challenger Amp. Co.** Model CH30 PA amplifier. Schematics or manuals. Ray Gill, 3717 Tidewater Trail, Fredericksburg, VA 22401.

**Tektronix** Model 513D oscilloscope. Schematic and/or service manual. David Mason, 1117 Woodland Dr., Tallahassee, FL 32304.

**RCA** radios, Models K-80 (Chassis No. RC-415-D) and 812-K, chassis No. 7Y-14(?). **Truetone** radio Model D-727, chassis No. 175E (175EAW). Schematics. Also want source for old radio tubes and **Rider** Radio Schematic Books No. 1-14. Milton Obuch, 1308 N. 4th St., Sayre, OK 73662.

**Cathedral-style** radio, with "TATRO-A" stenciled on bottom. Circa 1925. Contains 2 #38 tubes, 1 #75, 1 #78, and 1 6A7. **Magnavox** Model 154D 114-ohm speaker. Made to operate off a Delco generator/storage battery power plant. Any restoration information. F. Keith Haywood, Box 537, Angier, NC 27501.

**Scott** all-wave receiver, serial T-499. Chrome plated, two tweeters and a woofer (electrodynamic), 4 2A3 output tubes, neon regulator with bayonet base, 2 5U4-type rectifiers. Schematic and/or servicing info. Technical Engineering Laboratories, 787 Mesa Way, Richmond, CA 94805.

**Capital** Model HP-875 tape deck. Parts lists, source(s), schematics. Vaughan Williams, 6356 DeSoto, Detroit, MI 48238.

**Lancer** Model LA 1010 stereo amplifier. One output transformer (FT-3083445-B 100 6932) needed or source for same. Robert Davenport, 51 Meander Lane, Levittown, NY 11756.

**Precision** Model 10-12 tube and battery tester with G-104 adapter. Need updated tube roller chart or source for same. Phillip Coulter, 2023 1/2 Wheaton Ave., Millville, NJ 08332.

**E.H. Scott** navy-type receiver, Model RCH 1c2c-46209. Schematic and/or operator's manual. Randall Barbett, 36678 Suffolk Dr., Mt. Clemens, MI 48043.

**WWII-vintage** VLF receiver (15-600 kHz) Model CFT-46154 serial 649. Operator's manual, parts list, service info, and schematic needed. Tom Dycus, 1507 Katie NE, Albuquerque, NM 87110.

**Muskat** Model 72MPX10 FM/AM/Tape Player. Schematic and transformer needed. Sam Pope, Sam's TV Service, 717 5th St. SE, Hickory, NC 28601.

**Analog** 1120 oscilloscope type 700. Schematic diagram. Mihailo Repovic, 39 Pierce Rd., Watertown, MA 02172.

**Monroe** 820CRT calculator. Readout tube and schematic needed. Earl Leininger, Suite 500, Financial Center, 3443 N. Central Ave., Phoenix, AZ 85012.

**Dumont** Model 164-E oscilloscope. Schematic and/or service manual. Joseph Lipsky, Rte. 8, Box 264, Brooksville, FL 33512.

**Advantetron** Model 404A phase meter. User/service manuals and/or schematics. Wesley Kranitz, RR2, Box 823, Lot 357, Pompano Beach, FL 33067.

**Superior Instruments Co.** Model TD-55 tube tester. Accurate Instrument Co. Model 154 VOM. Service manuals and/or schematics. Frank Waldren, Box 13305, St. Louis, MO 63157.

**Nippon Sound Co.** AM/FM Stereo Serial No. 1105. Schematic. Richard Gillespie, 6147 Oakbank Dr., Azusa, CA 91702.

**RCA** CTC9N receiver with remote control CTP7A. Any service information on remote control receiver or transmitter CRK3A. Robert Brandenburg, 1400 Albany St., Apt. 2, Los Angeles, CA 90015.

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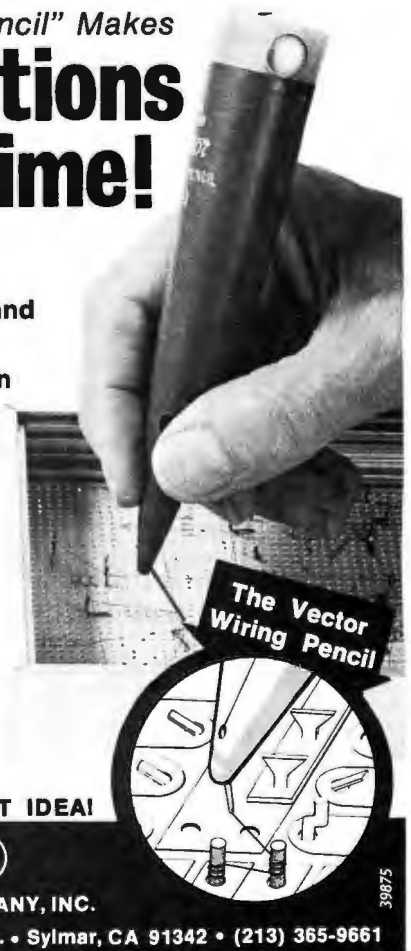
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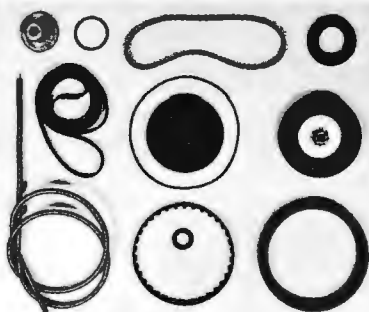
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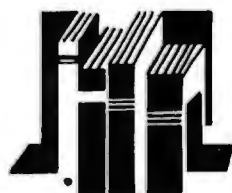
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Published by Ken Cornell, 225 Baltimore Ave., Pt. Pleasant Beach, NJ 08742. 105 pages (8½" × 11"). \$4.75, soft cover.

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Published by McGraw-Hill Book Co., 1221 Ave. of the Americas, New York, NY 10020. 170 pages (8½" × 11"). \$6.96 soft cover.

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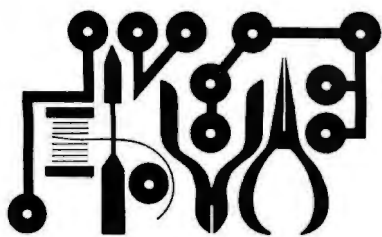
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# Experimenter's Corner

By Forrest M. Mims

## THE LIGHT-ACTIVATED SCR

**T**HE SCR has been around for some time, and most of us have used them in a variety of circuits. There's one SCR, however, that doesn't get much experimenter use. It's the so-called LASCR (Light Activated Silicon Controlled Rectifier).

Lots of the parts dealers now sell LASCR's at bargain-basement prices. Depending on the voltage rating, you can buy good quality units at prices less than 50¢ to about \$1.75. Not bad for a component with lots of practical uses.

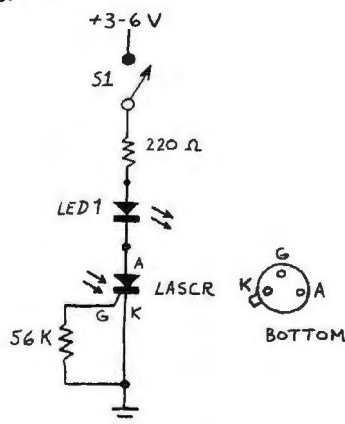


Fig. 1. LASCR test rig.

You can make a simple LASCR test rig in a couple of minutes with an LED, a couple of resistors, a switch, and two flashlight cells. Connect the parts as shown in Fig. 1 and you're in business. First close S1. Normally the LASCR will be off, but an increase in the light level at its sensitive surface will generate a photocurrent which will turn the

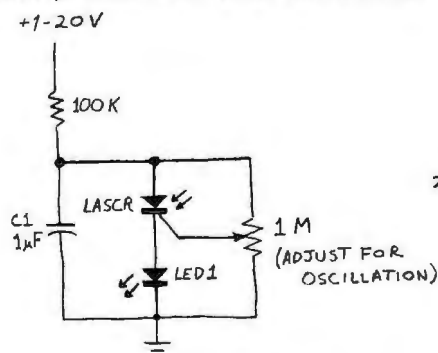


Fig. 2. Relaxation oscillator.

device on. The resulting current will light up the LED. Open S1 to turn the LASCR off.

Figure 2 is a neat little circuit in which the LASCR operates as a low-voltage relaxation oscillator. Capacitor C1 charges to the supply voltage through the 100,000-ohm resistor. The potentiometer is a voltage divider which feeds some of the charge on C1 to the LASCR's gate. When its turn-on voltage is reached, the LASCR switches on and dumps the charge on C1 through the LED. Since C1 is now discharged, the LASCR turns off, C1 begins charging again, and the cycle repeats.

I've operated this circuit from slightly less than one volt! You may have to adjust the light level at the LASCR with a flashlight to start the oscillator at very low voltages.

Like any SCR, the LASCR is a four-layer, three-junction device whose structure is shown in Fig. 3. The anode and gate connections form two terminals of a pnp transistor. There is no base lead, so you cannot use a conventional SCR as a transistor. But you can use the anode-gate leads of a LASCR as a pnp phototransistor. To do this, hook up the test circuit in Fig. 4. Toss some light on the LASCR and you've got an instant light meter. I measured 10 µA forward current from a typical LASCR basking in the rays from a #222 lamp 50 mm away.

So far we've just been tinkering around so now let's get down to business with a circuit that really exploits the versatility of the LASCR. The circuit in Fig. 5 (a slave flash) is ideal for supplying filler light for flash photos. If photography isn't your thing, you might want to use the circuit for a novelty device or as a demonstration of how a relatively puny pulse of light can trigger an eye-dazzling flash from a powerful xenon lamp.

The circuit is a conventional strobe, but don't let its simplicity deceive you! Capacitor C1 will be charged to a voltage high enough to vaporize a screwdriver tip, so use care when building the circuit. Mount all the parts on a piece of perf board, use insulated hookup wire, and cover all

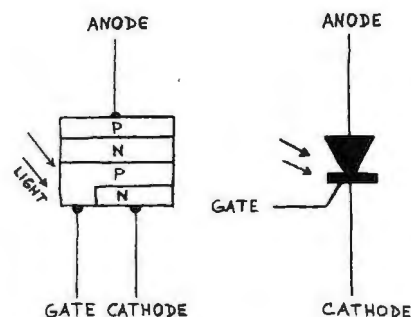


Fig. 3. Structure of LASCR.

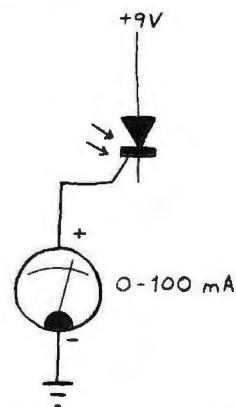


Fig. 4. Light-meter circuit.

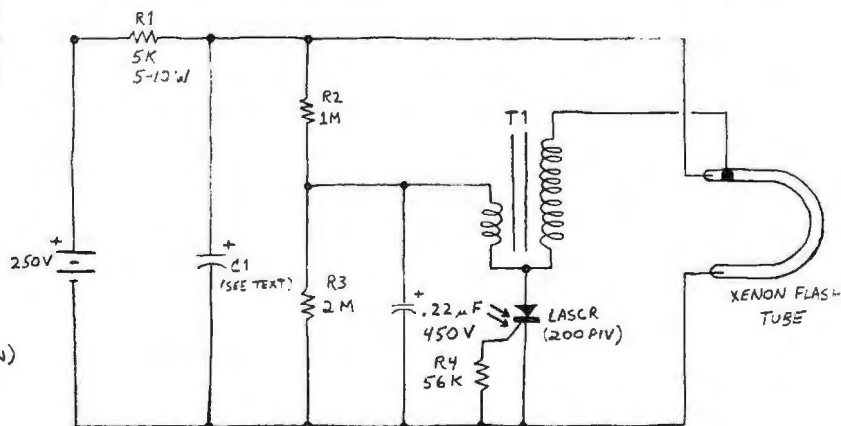


Fig. 5. Slave flash for photography.

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exposed leads and junctions with sleeving and corona dope for safety. Then house the entire circuit in an insulated enclosure with an aperture for the flash tube.

You can power the circuit with a 300-volt dry battery or a combination of batteries which gives 250 to 300 volts. Buy your battery from a dealer who sells lots of high-voltage batteries to make sure you get a fresh one.

Use an electrolytic capacitor for C1. Several hundred microfarads will give you plenty of light, and you can probably get by with a lot less than that. Use a 450-volt unit and be sure to observe polarity. Use any standard trigger transformer for T1 and any xenon flash tube.

Incidentally, a good source for parts for this project is the cheap flash units originally designed for discontinued Instamatic™ cameras. Several surplus dealers sell these units for about \$10. You might be able to pick up some trade-in flash units at camera stores for a few bucks.

Figure 6 is a scope photo of several half-millisecond flashes from a LASCR triggered slave flash. It's fairly

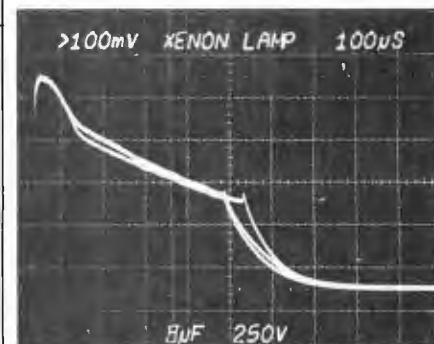


Fig. 6. Scope photo of triggered slave flash.

impressive when you can trigger a brilliant burst of light with just a little penlight.

You can make the LASCR immune to ordinary lights by adding a 1-henry inductor across R4. The choke will appear as a short circuit to steady-state and slow transients, keeping the LASCR off. But a very fast pulse from a master flash unit will bypass the choke (which will appear as an open circuit) and turn on the LASCR.

These are just a few uses for the remarkably versatile and often overlooked LASCR. Pick up a few and try them out. You'll probably come up with some applications of your own.



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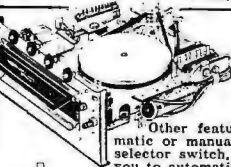
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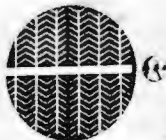
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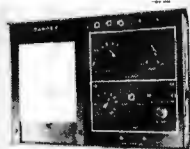
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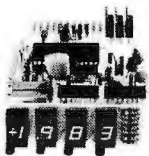
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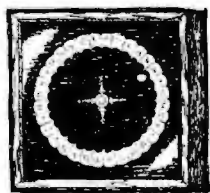
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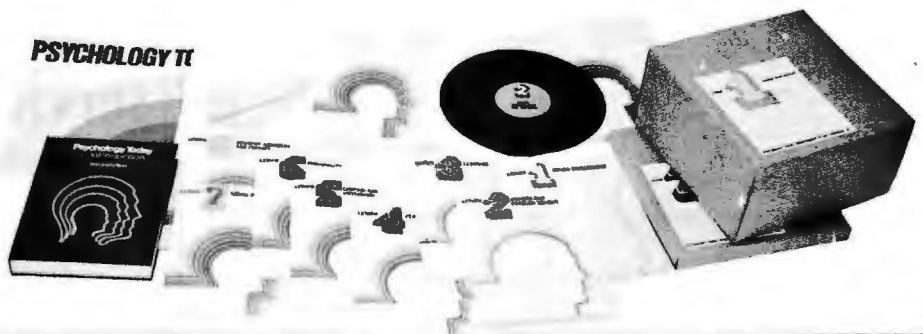
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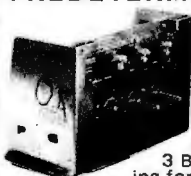
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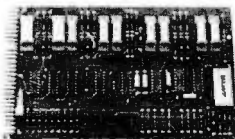
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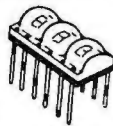
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7808-16c	7475-65c	74161-99c
7410-16c	7476-39c	74163-1.19
7413-49c	7483-85c	74164-1.89
7420-16c	7490-69c	74165-1.49
7427-24c	7492-75c	74174-1.29
7430-16c	7493-75c	74175-1.39
7437-39c	7495-75c	74181-2.75
7438-35c	7496-75c	74192-1.25
7440-16c	74121-38c	74193-1.25
7442-69c	74123-75c	74195-79c
7447-89c	74150-70c	74197-79c

## COMPUTER BOARD BONANZA

We bought over 4 tons of assorted boards. Contains TTL, diodes, transistors, etc. 5 board asmt. with 150 to 250 IC's — \$3.95.

## DIGITAL ALARM CLOCK IC

The newest and easiest to use alarm chip on the market today. Features:



1. Single supply voltage.
2. LED intensity control
3. Simple time set.
4. 4 or 6 Digit LED Display
5. AM-PM Indication
6. 24 Hr. Alarm.
7. 10 minute snooze.
8. Outperforms MM5316

Order #70250 — \$4.99

## MM5314

## NATIONAL CLOCK CHIP

The most popular clock chip around. We made a huge special purchase of factory fresh, prime units. Lowest price in USA. 24 Pin DIP. 4 or 6 Digits. With Specs. \$3.95

## DOUBLE DIGIT JUMBO READOUTS

New. Litronix 727. Dual. Perfect for giant clocks, etc. \$3.95 each (2 DIGITS)

## JUMBO LED READOUT

Twice the size of regular readouts. .65 inches. Like Litronix DL747. Outperforms and easier to read than SLA-3, only 20 MA per segment. Our best readout for digital clocks. \$2.95 ea. (6 FOR \$15) Common Anode

## FILTER CAPS

1000 MFD 16VDC upright style. 4 FOR \$1

## 8038 FUNCTION GENERATOR

Brand new. Voltage controlled oscillator. Has sine, square wave, and triangular outputs. \$4.95 each.

## IN4148 DIODES

Brand New Units. Same as IN914. Full Leads. 25 For \$1

## MONSANTO COLORED READOUTS

.27 IN. Character. Common Anode. MAN5 — GREEN — \$1.29 MAN 8 — YELLOW — \$1.29

## PHASE LOCKED LOOP

565A by Signetics. Extremely stable. High linearity, wide frequency range. TTL compatible. Perfect for tone decoders, FSK, SCA receivers, frequency multiplication and division — 99c WITH SPECS

## FLOURESCENT READOUT TUBES

7 Segments. Blue-Green in color. Mfg. by ISE. #DG8F. The most popular display used in many imported clocks and calculators. Perfect for use with MM5316 clock chips.

SUPER SPECIAL 69c ea. 12 For \$5.95

## GE TRANSISTOR ASSORTMENT

One of the best mixed transistor lots we have seen. TO-98 Plastic cased. Includes Darlington's, SCR's, PNP, NPN, etc. Un-tested sample test shows very high yield. Satisfaction assured. 50 for 99c. SPECIAL: 6 BAGS FOR \$5.

## COLOR ORGAN CONTROL MODULE

Completely self-contained. Has SCR circuitry, AC line cord, etc. From a close out by a mfg. of color organs. New, unused. \$1.49

## MOTOROLA SCR

2N4443 8 Amp 400PN, Plastic Power Case. 69c

## GE POWER DARLINGTON

NPN, Plastic Power Tab Case. VCEO-30 HFE-30,000 TYP. Brand new units, but leads are slightly trimmed for P.C.B. #D40C1 — SPECIAL 4 For \$1

## RCA PHOTO DETECTOR — POWER AMP. IC

RCA CA3062 for photoelectric applications. The IC with a window. Contains photosensitive section, amplifier, and high current output pair of transistors. Has 100 MA output. Useful for intrusion alarms, counters, position sensors, etc. with complete spec sheets. Reg. \$4.84. SPECIAL — \$1.99

## LOOK MOS 4 DIGIT COUNTER

An ALTJ exclusive. These are the latest state of the art. MOS chips. By a famous US mfg. Contains a complete 4 digit counter, including 4 decade counters, latches, multiplexing circuits, display decoders, etc. Features: 5VDC operation, 25 MW power consumption, both 7 segment and BCD outputs. Perfect for making DVM's frequency meters, tachometers, stopwatches, or any other device requiring 4 or more digits. Complete with specs 28 PIN DIP, QTY Limited. SPECIAL — \$12.50 BACK IN STOCK!

## LED DRIVER IC'S

75491 Quad segment dr. — 29c 75492 Hex digit dr. — 39c

## RCA CA3043 — FM IC

Used in FM stereos. Contains IF Amp, Limiter, FM Detector, and an Audio Preamp and Driver all in one 12 lead TO-5 package. With Spec Sheets. A \$3.00 Value — 99c

## 4 DIGIT ALARM CLOCK KIT

Features the only LED direct drive clock chip on the market. Kit includes all parts (except X fmr) for a 4 Digit alarm clock kit. Uses .25 inch LED readouts. SPECIAL: \$15.95 (with PC Board)

## 6 DIGIT LED READOUTS

Brand new arrays by T. I. Common cathode, properly multiplexed. Six digits plus a negative sign. Perfect for calculators, mini-clocks, stop watches, etc. SUPER SPECIAL \$1.29 ea 3 for \$3

## U.V. ERASEABLE PROMS

New Prime units by National MM5203 2K \$14.95 MM5204 4K \$19.95

## TRANSISTOR BAKER'S DOZEN SALE!

2 million pieces bought for this sale. New house numbered units by T.I. All prime first quality at a give-away price. NPN 2N3904-13 For \$1 PNP 2N3906-13 For \$1

## In4004 RECTIFIERS

1 AMP 400PIV SPECIAL 15/\$1

## 7805 STYLE REGULATORS

TO-220 Plastic Case 5VDC Regulator. Brand New by National — 99c

## FACTORY NEW LED'S

Jumbo Red-Like MV5024-8/\$1 Jumbo Green-Like MV5222-5/\$1 Jumbo Yellow-5/\$1 Mini Red-Like MV50-10/\$1

## FORD SOLID STATE MODULES

Mfg. by Contralab for Ford car radios. Each module contains 2 transistors plus other components. These modules were used as audio pre amps. We include specs. — 4 For \$1

## TTL IC ASSORTMENT

Various types. Most are marked. Our best selling assortment. Un-tested but includes many useable devices. 200 PCS FOR \$3.95

## FM TRANSFORMERS

We bought a load of coils and transformers that were used in Ford AM-FM car radios. Includes 19KHZ, 38KHZ, OSC. Coils, etc. All New. Perfect for experimenters or repairmen. 10 Pc Asst. — 99c

## TANTALUM CAPS

By Sprague. 4.7 MFD 10 VDC. Axial Leads. Perfect for timers. 10 For \$1

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Miniature size. Primary 115V AC Secondary 11V AC No Load. 8V AC with 400 MA Load. Perfect for clocks or calculators or small power supply. 99c

## Altaj Electronics

P.O. Box 38544 Dallas, Texas 75238

TERMS: Check or money order. No. COD. Add 10% Pstg. and Hdlg. Tex Res. add 5%.

## C-MOS

CD4000 . . . . .24	CD4015 .1.19	CD4026 .1.49	CD4044 . . .59
CD4001 . . . . .24	CD4016 . . .59	CD4027 . . .59	CD4047 . . .59
CD4002 . . . . .24	CD4017 .1.29	CD4028 . . .99	CD4049 . . .59
CD4006 . . .1.49	CD4018 .1.49	CD4029 .1.39	CD4050 . . .59
CD4007 . . . . .24	CD4019 . . .59	CD4030 . . .49	CD4066 . . .99
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CD4009 . . . . .59	CD4021 .1.49	CD4033 .1.49	74C02 . . .29
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CD4012 . . . . .24	CD4023 . . .24	CD4040 .1.59	74C107 .1.29
CD4013 . . . . .59	CD4024 . . .99	CD4041 . . .89	
CD4014 . . .1.49	CD4025 . . .24	CD4042 . . .79	



## TTL

SN7400	\$ .15	SN74121	.38
7401	.15	74122	.44
7402	.15	74123	.74
7403	.15	74125	.54
7404	.18	74126	.54
7405	.18	74128	.64
7406	.18	74132	1.45
7407	.34	74136	.64
7408	.18	74141	.94
7409	.18	74142	.70
7410	.15	74143	.39
7411	.25	74144	.39
7412	.30	74145	.39
7413	.45	74147	2.30
7414	1.49	74148	1.90
7416	.33	74150	.94
7417	.33	74151	.89
7420	.15	74153	.79
7421	.32	74154	.79
7423	.27	74155	.79
7425	.27	74156	.79
7426	.24	74157	.69
7427	.27	74159	3.50
7428	.39	74160	.99
7430	.15	74161	.99
7432	.37	74162	.99
7433	.37	74163	.99
7437	.29	74164	1.10
7438	.29	74165	1.10
7440	.15	74166	1.35
7442	.59	74170	2.25
7443	.85	74172	8.75
7444	.85	74173	1.35
7445	.79	74174	1.35
7446	.85	74175	.99
7447	.85	74176	.79
7448	.85	74177	.79
7450	.15	74178	1.95
7451	.15	74179	.75
7453	.15	74180	.79
7454	.15	74181	2.40
7456	.15	74182	.69
7457	.15	74183	.69
7472	.28	74185	1.85
7473	.34	74186	1.95
7474	.34	74188	1.75
7475	.49	74190	1.33
7476	.35	74191	1.33
7480	.49	74192	1.33
7481	.99	74193	1.10
7482	.69	74194	1.05
7483A	.74	74195	.74
7484	1.95	74196	.99
7485	1.08	74197	.89
7486	.34	74198	1.69
7489	2.35	74199	1.69
7490	.49	74221	1.50
7491	.79	74246	1.95
7492	.49	74247	1.95
7493	.49	74248	1.75
7494	.79	74249	1.75
7495	.79	74251	1.40
7499	.79	74265	.85
74100	1.25	74273	2.75
74104	.43	74278	2.45
74105	.43	74283	1.75
74107	.34	74284	4.50
74109	.74	74285	4.50
74110	.74	74290	.85
74116	.98	74293	.85
74118	1.35	74295	1.98
74120	1.40	74367	.95

## C/MOS

CD4000	\$ .24	CD4033	1.95
4001	.24	4035	1.95
4002	.24	4040	.89
4006	1.50	4041	.89
4007	.24	4042	.79
4008	.24	4043	.79
4009	.49	4044	.79
4010	.49	4049	.49
4011	.49	4050	.49
4012	.24	4051	1.50
4013	.49	4052	1.50
4014	1.24	4053	1.50
4015	1.24	4054	1.50
4016	.49	4056	.99
4017	1.24	4060	1.99
4018	.49	4066	.79
4019	.49	4069	.35
4020	1.24	4071	.35
4021	1.24	4076	1.24
4022	1.24	4081	.35
4023	.24	4507	1.25
4024	.24	4510	1.25
4025	.24	4511	2.50
4026	1.95	4512	2.95
4027	.59	4516	1.75
4028	.59	4518	1.75
4029	1.24	4520	1.95
4030	.49	4528	1.50

## LINEAR I.C.'s

LM300H	Positive Voltage Regulator	(metal can)	.69
LM301AH	Hi Performance Op Amp	(metal can)	.35
LM304H	Negative Voltage Regulator	(metal can)	.75
LM305H	Positive Voltage Regulator	(metal can)	.78
LM307H	Op Amp (Super 741)	(mini dip)	.28
LM307 mini	Op Amp (Super 741)	(mini dip)	.28
LM309H	SV 1 Amp Voltage Regulator	(TO-3)	1.39
LM310H	Voltage Follower Op Amp	(metal can)	1.09
LM324	Quad Op Amp	(DIP)	1.75
LM339	Quad Comparator	(mini dip)	.54
LM555	Timer	(mini dip)	.29
LM559	Dual Timer	(mini dip)	.29
LM709CH	Op Amp	(mini dip)	.29
LM709CH mini	Op Amp	(mini dip)	.29
LM711CH	Dual Difference Comparator	(metal can)	.50
LM723CH	Voltage Regulator	(metal can)	.54
LM723CH mini	Voltage Regulator	(14 pin DIP)	.54
LM741CH	Op Amp	(mini dip)	.28
LM741CH mini	Op Amp	(14 pin DIP)	.28
LM747CH	Dual 741 Op Amp	(mini dip)	.29
LM747CH mini	Dual 741 Op Amp	(14 pin DIP)	.29
LM748CH mini	Dual 741 Op Amp	(mini dip)	.29
LM1458H	Op Amp	(metal can)	.85
LM3046	Transistor Array		.79
LM3900	Quad Amplifier		

## MEMORIES

AT5-1013P	UART		
AT5-2375	Keyboard Encoder ROM	\$ 9.00	
1101AP	256 Bit Static RAM MOS	3.95	
1403AT	Dual 512 Bit Dyn MOS S/R	3.75	
1404AT	Single 1024 Bit Dyn MOS S/R	3.50	
1702A	2048 Bit Erasable Elect. Reprogrammable	23.95	
2102P	Static MOS RAM	3.95	
1024 Bt Static RAM MOS		22.95	
8008R	8 Bit Central Processing Unit	44.00	
8080	8 Bit Parallel CPU	195.00	
TMS4030NL	4K RAM 4096 Bit	19.95	

## EXAR I.C.'s

XR-100K	XR-Chip Custom IC Design Kit	79.00
XR-8101	NPN Transistor Array, Small Signal	3.45
XR-8102	PNP Transistor Array, Small Signal	3.45
XR-C101	NPN Transistor Array, Small Signal	3.45
XR-C102	PNP Transistor Array, Lateral & Substrate	3.45
XR-C103	NPN Transistor Array, Power & Schottky	3.45
XR-C104	Diffused Resistor Array	3.45
XR-C105	Diffused & Pinch Resistor Array	3.45
XR-C106	Diffused & Pinch Resistor Array	3.45
XR-201	Multi-Function IC	20.95
XR-205	Waveform Generator IC	6.25
XR-205K	Waveform Generator Kit	24.50
XR-210	FSK Modulator Demodulator	3.89
XR-210M	FSK Modulator Demodulator	7.75
XR-215	General Purpose PLL	1.91
XR-320	Timing Circuit	2.15
XR-555CP	Timing Circuit	7.91
XR-555M	Dual Timing Circuit	2.15
XR-556CP	Dual Timing Circuit	1.25
XR-556M	Dual Timing Circuit	9.71
XR-567CP	Tone Decoder	2.39
XR-567M	Tone Decoder	1.25
XR-567CP	Tone Decoder	2.39
XR-1310P	Stereo Demodulator	2.50
XR-1310EP	Stereo Demodulator	1.85
XR-1468CP	±5V Tracking Voltage Regulator	4.25
XR-1468M	±5V Tracking Voltage Regulator	1.25
XR-1488N	Quad Line Driver	3.55
XR-1488P	Quad Line Driver	3.55
XR-1489AN	Quad Line Receiver	3.55
XR-1489AP	Quad Line Receiver	3.55
XR-1568M	±15 Volt Tracking Voltage Regulator	1.20
XR-1568N	±15 Volt Tracking Voltage Regulator	5.35
XR-1800P	Stereo Decoder	2.39
XR-2206N	Monolithic Function Generator	8.15
XR-2206P	Monolithic Function Generator	7.67
XR-2206CN	Monolithic Function Generator	4.61
XR-2206CP	Monolithic Function Generator	3.83
XR-2207M	Voltage-Controlled Oscillator	11.50
XR-2207N	Voltage-Controlled Oscillator	5.03
XR-2207CN	Voltage-Controlled Oscillator	2.85
XR-2207CP	Voltage-Controlled Oscillator	13.30
XR-2208M	Operational Multiplier	5.93
XR-2208P	Operational Multiplier	4.19
XR-2208CN	Operational Multiplier	3.99
XR-2208CP	Operational Multiplier	5.67
XR-2210M	FSK Demodulator/Tone Decoder	5.15
XR-2210P	FSK Demodulator/Tone Decoder	14.63
XR-2240M	Programmable Timer/Counter	5.39
XR-2240P	Programmable Timer/Counter	4.87
XR-2240CN	Programmable Timer/Counter	3.59
XR-2240CP	Programmable Timer/Counter	7.91
XR-2555M	Dual 555 Timer	2.63
XR-2556M	Dual 555 Timer	2.70
XR-2567CP	Dual 567 Tone Decoder	5.92
XR-2567CP	Dual 567 Tone Decoder	3.88

## PLASTIC POWER TRANSISTORS

TIP29A	NPN	1A 60V	\$ .45
TIP30A	PNP	1A 60V	.49
TIP31A	NPN	3A 60V	.52
TIP32A	PNP	3A 60V	.55
TIP34	PNP	10A 40V	.99
TIP35	PNP	10A 40V	.99
TIP36	PNP	25A 40V	2.25
TIP41A	NPN	6A 60V	.65
TIP42A	PNP	6A 60V	.75
TIP43A	NPN	1A 350V	.99
TIP48	NPN	1A 300V	.96
TIP49	NPN	1A 350V	.99
TIP110	NPN	1A 60V	1.64
TIP121	NPN	5A 80V	1.64
TIP127	PNP	5A 100V	2.02
TIP128	PNP	15A 60V	.85
TIP3055	NPN	15A 60V	.85

## I.C. SOCKETS

8 Pin DIL	\$ .18	16 Pin DIL	.24
14 Pin DIL	.22	24 Pin DIL	.59

## LED's & OPTO ISOLATORS

DL707	7 Seg 0.3"	\$1.70
DL747	7 Seg 0.63"	2.45
RL2	Red Led .19"	.23
RL209	Red Led .125"	.15
TL111	Opto-Coupler	1.20
TL220	Red Led .20"	.24
IL15	Opto-Isolator	1.40
TL1312	7 Seg. 0.3"	1.70
TL1313	7 Seg. 0.3"	1.70

## PLASTIC TRANSISTORS

2N3415	.15
2N3550	.15
2N3554	.15
2N3555	.15
2N3556	.15
2N3557	.15
2N3558	.15
2N3559	.15
2N3560	.15
2N3561	.15
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2N3599	.15
2N3600	.15
2N3601	.15
2N3602	.15
2N3603	.15
2N3604	.15
2N3605	.15
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2N3674	.15
2N3675	.15
2N3676	.15
2N3677	.15
2N3678	.15
2N3679	.15

# EXAR FUNCTION GENERATOR KITS



features sine, triangle and square wave; THD 0.5% typ.; AM/FM capability

## XR-2206KA

Includes monolithic function generator IC, PC board, and assembly instruction manual.  
Same as XR-2206KA above and includes external components for PC board.

## TIMERS

XR-555CP Monolithic Timer  
XR-320P Precision Timer  
XR-555CP Dual-555 Timer  
XR-2556CP Dual Timing Circuit  
XR-2240CP Programmable Counter/Timer

## PHASE LOCKED LOOPS

XR-210 FSK Demodulator  
XR-215 High Frequency PLL  
XR-567CT Tone Decoder (mini DIP)  
XR-567CT Tone Decoder (TO-5)

## STEREO DECODERS

XR-1310P PLL Stereo Decoder  
XR-1310EP PLL Stereo Decoder  
XR-1800P PLL Stereo Decoder

## WAVEFORM GENERATORS

XR-205 Waveform Generator  
XR-2206CP Monolithic Function Generator  
XR-2207CP Voltage-Controlled Oscillator

## OTHER EXAR IC'S

XR-1458CN Dual 15V Tracking Regulator  
XR-1488N Quad Line Driver  
XR-1489AN Quad Line Receiver  
XR-2208CP Operational Multiplier  
XR-2211CP FSK Demodulator/Tone Decoder  
XR-2261 Monolithic Proportional Servo IC System w/4 ea. Driver Transistor

## SPECIAL \$ .68

1.50  
1.70  
3.10  
3.20

## SPECIAL \$ .99

5.10  
6.50  
1.90

## SPECIAL \$ .83

4.39  
3.75

## SPECIAL \$ 2.90

5.70  
4.70  
5.10  
6.60  
3.70

## 7400N TTL

7400N	.13	7443N	.95	74104N	1.20	74165N	1.30
7401N	.16	7444N	1.05	74105N	.50	74166N	1.30
7402N	.14	7445N	.90	74107N	.30	74170N	2.50
7403N	.16	7446N	.90	74109N	.30	74173N	1.60
7404N	.19	7447N	.80	74110N	.72	74174N	1.10
7405N	.20	7448N	.80	74111N	.83	74175N	1.20
7406N	.29	7449N	.16	74112N	1.52	74176N	1.25
7407N	.29	7451N	.16	74112N	.45	74177N	1.40
7408N	.18	7453N	.16	74122N	.45	74180N	.73
7409N	.20	7454N	.16	74123N	.70	74181N	3.00
7410N	.18	7456N	.16	74125N	.70	74182N	2.00
7411N	.26	7457N	.32	74126N	.50	74184N	2.00
7412N	.33	7472N	.30	74128N	.90	74185N	2.29
7413N	.68	7473N	.37	74132N	1.00	74188N	4.80
7414N	1.23	7474N	.32	74138N	.95	74190N	1.20
7415N	.28	7475N	.59	74141N	1.20	74191N	1.20
7416N	.33	7476N	.32	74148N	1.00	74192N	1.20
7417N	.37	7480N	.59	74147N	2.40	74193N	1.00
7418N	.33	7481N	1.18	74148N	1.80	74194N	1.15
7419N	.60	7482N	.89	74150N	1.00	74195N	.80
7420N	.50	7483N	.85	74151N	.80	74196N	1.70
7421N	.34	7484N	3.00	74152N	1.00	74197N	1.70
7422N	.26	7485N	1.20	74153N	1.00	74198N	1.75
7423N	.31	7486N	.35	74154N	1.40	74199N	1.40
7424N	.50	7487N	2.30	74155N	1.00	74200N	5.60
7425N	.30	7488N	.60	74156N	1.18	74221N	1.70
7426N	.24	7489N	.90	74157N	1.00	74251N	2.00
7427N	.30	7490N	.55	74158N	1.20	74278N	2.95
7428N	.36	7493N	.68	74160N	1.30	74279N	.90
7429N	.33	7494N	.80	74161N	1.20	74293N	1.00
7430N	.36	7495N	.80	74162N	1.40	74298N	2.20
7431N	.16	7440N	1.50	74163N	1.40		
7441N	.95	74100N	1.00	74164N	1.20		
7442N	.80						

## HIGH SPEED TTL

74H00N	.33	74H20N	.33	74H53N	.36	74H73N	.90
74H01N	.28	74H21N	.33	74H54N	.36	74H74N	.87
74H02N	.30	74H22N	.33	74H55N	.36	74H75N	.80
74H03N	.33	74H23N	.33	74H56N	.36	74H101N	.80
74H04N	.33	74H24N	.36	74H57N	.36	74H102N	.80
74H05N	.33	74H25N	.36	74H58N	.36	74H103N	1.10
74H06N	.40	74H26N	.36	74H59N	.36	74H104N	.95
74H07N	.40	74H27N	.36	74H60N	.36	74H105N	.95
74H08N	.40	74H28N	.36	74H61N	.36	74H106N	.95
74H09N	.40	74H29N	.36	74H62N	.36		
74H10N	.40	74H30N	.36	74H63N	.36		
74H11N	.40	74H31N	.36	74H64N	.36		

## LOW POWER TTL

74L00N	.31	74L10N	.33	74L51N	.34	74L90N	1.62
74L01N	.33	74L11N	.33	74L52N	.69	74L91N	1.62
74L02N	.33	74L12N	.33	74L53N	.69	74L92N	1.62
74L03N	.39	74L13N	1.49	74L54N	.90	74L93N	1.62
74L04N	.33						

## 74LS

74LS00	.48	74LS27	.50	74LS112	.58	74LS170	5.80
74LS01	.68	74LS30	.46	74LS113	.92	74LS171	2.20
74LS02	.40	74LS32	.50	74LS138	2.06	74LS172	2.42
74LS03	.50	74LS33	.58	74LS114	2.06	74LS173	2.06
74LS04	.50	74LS31	.50	74LS115	1.92	74LS194	2.40
74LS05	.46	74LS34	.58	74LS153	1.92	74LS195A	2.40
74LS06	.58	74LS35	.68	74LS157	1.68	74LS196	2.78
74LS07	.46	74LS36	.68	74LS158	1.68	74LS197	2.06
74LS08	.58	74LS37	.92	74LS160	3.06	74LS253	2.42
74LS09	.58	74LS38	.92	74LS161	3.06	74LS252	2.06
74LS10	.46	74LS39	.92	74LS163	3.06	74LS254	2.06
74LS11	.46	74LS74	.68	74LS169	2.90	74LS260	.68
74LS15	.58	74LS78	.92				
74LS20	.46	74LS79	.92				
74LS21	.58	74LS107	.92				
74LS22	.58	74LS109	.92				

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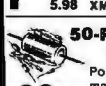
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7417N	24c	7470N	72c	4036AE	24c
7418N	24c	7471N	72c	4037AE	24c
7419N	24c	7472N	72c	4038AE	24c
7420N	24c	7473N	72c	4039AE	24c
7421N	24c	7474N	72c	4040AE	24c
7422N	24c	7475N	72c	4041AE	24c
7423N	24c	7476N	72c	4042AE	24c
7424N	24c	7477N	72c	4043AE	24c
7425N	24c	7478N	72c	4044AE	24c
7426N	24c	7479N	72c	4045AE	24c
7427N	24c	7480N	72c	4046AE	24c
7428N	24c	7481N	72c	4047AE	24c
7429N	24c	7482N	72c	4048AE	24c
7430N	24c	7483N	72c	4049AE	24c
7431N	24c	7484N	72c	4050AE	24c
7432N	24c	7485N	72c	4051AE	24c
7433N	24c	7486N	72c	4052AE	24c
7434N	24c	7487N	72c	4053AE	24c
7435N	24c	7488N	72c	4054AE	24c
7436N	24c	7489N	72c	4055AE	24c
7437N	24c	7490N	72c	4056AE	24c
7438N	24c	7491N	72c	4057AE	24c
7439N	24c	7492N	72c	4058AE	24c
7440N	24c	7493N	72c	4059AE	24c
7441N	24c	7494N	72c	4060AE	24c
7442N	24c	7495N	72c	4061AE	24c
7443N	24c	7496N	72c	4062AE	24c
7444N	24c	7497N	72c	4063AE	24c
7445N	24c	7498N	72c	4064AE	24c
7446N	24c	7499N	72c	4065AE	24c
7447N	24c	7500N	72c	4066AE	24c
7448N	24c	7501N	72c	4067AE	24c
7449N	24c	7502N	72c	4068AE	24c
7450N	24c	7503N	72c	4069AE	24c
7451N	24c	7504N	72c	4070AE	24c
7452N	24c	7505N	72c	4071AE	24c
7453N	24c	7506N	72c	4072AE	24c
7454N	24c	7507N	72c	4073AE	24c
7455N	24c	7508N	72c	4074AE	24c
7456N	24c	7509N	72c	4075AE	24c
7457N	24c	7510N	72c	4076AE	24c
7458N	24c	7511N	72c	4077AE	24c
7459N	24c	7512N	72c	4078AE	24c
7460N	24c	7513N	72c	4079AE	24c
7461N	24c	7514N	72c	4080AE	24c
7462N	24c	7515N	72c	4081AE	24c
7463N	24c	7516N	72c	4082AE	24c
7464N	24c	7517N	72c	4083AE	24c
7465N	24c	7518N	72c	4084AE	24c
7466N	24c	7519N	72c	4085AE	24c
7467N	24c	7520N	72c	4086AE	24c
7468N	24c	7521N	72c	4087AE	24c
7469N	24c	7522N	72c	4088AE	24c
7470N	24c	7523N	72c	4089AE	24c
7471N	24c	7524N	72c	4090AE	24c
7472N	24c	7525N	72c	4091AE	24c
7473N	24c	7526N	72c	4092AE	24c
7474N	24c	7527N	72c	4093AE	24c
7475N	24c	7528N	72c	4094AE	24c
7476N	24c	7529N	72c	4095AE	24c
7477N	24c	7530N	72c	4096AE	24c
7478N	24c	7531N	72c	4097AE	24c
7479N	24c	7532N	72c	4098AE	24c
7480N	24c	7533N	72c	4099AE	24c
7481N	24c	7534N	72c	4100AE	24c
7482N	24c	7535N	72c	4101AE	24c
7483N	24c	7536N	72c	4102AE	24c
7484N	24c	7537N	72c	4103AE	24c
7485N	24c	7538N	72c	4104AE	24c
7486N	24c	7539N	72c	4105AE	24c
7487N	24c	7540N	72c	4106AE	24c
7488N	24c	7541N	72c	4107AE	24c
7489N	24c	7542N	72c	4108AE	24c
7490N	24c	7543N	72c	4109AE	24c
7491N	24c	7544N	72c	4110AE	24c
7492N	24c	7545N	72c	4111AE	24c
7493N	24c	7546N	72c	4112AE	24c
7494N	24c	7547N	72c	4113AE	24c
7495N	24c	7548N	72c	4114AE	24c
7496N	24c	7549N	72c	4115AE	24c
7497N	24c	7550N	72c	4116AE	24c
7498N	24c	7551N	72c	4117AE	24c
7499N	24c	7552N	72c	4118AE	24c
7500N	24c	7553N	72c	4119AE	24c
7501N	24c	7554N	72c	4120AE	24c
7502N	24c	7555N	72c	4121AE	24c
7503N	24c	7556N	72c	4122AE	24c
7504N	24c	7557N	72c	4123AE	24c
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7507N	24c	7560N	72c	4126AE	24c
7508N	24c	7561N	72c	4127AE	24c
7509N	24c	7562N	72c	4128AE	24c
7510N	24c	7563N	72c	4129AE	24c
7511N	24c	7564N	72c	4130AE	24c
7512N	24c	7565N	72c	4131AE	24c
7513N	24c	7566N	72c	4132AE	24c
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7516N	24c	7569N	72c	4135AE	24c
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7519N	24c	7572N	72c	4138AE	24c
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7523N	24c	7576N	72c	4142AE	24c
7524N	24c	7577N	72c	4143AE	24c
7525N	24c	7578N	72c	4144AE	24c
7526N	24c	7579N	72c	4145AE	24c
7527N	24c	7580N	72c	4146AE	24c
7528N	24c	7581N	72c	4147AE	24c
7529N	24c	7582N	72c	4148AE	24c
7530N	24c	7583N	72c	4149AE	24c
7531N	24c	7584N	72c	4150AE	24c
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7548N	24c	7601N	72c	4167AE	24c
7549N	24c	7602N	72c	4168AE	24c
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7552N	24c	7605N	72c	4171AE	24c
7553N	24c	7606N	72c	4172AE	24c
7554N	24c	7607N	72c	4173AE	24c
7555N	24c	7608N	72c	4174AE	24c
7556N	24c	7609N	72c	4175AE	24c
7557N	24c	7610N	72c	4176AE	24c
7558N	24c	7611N	72c	4177AE	24c
7559N	24c	7612N	72c	4178AE	24c
7560N	24c	7613N	72c	4179AE	24c
7561N	24c	7614N	72c	4180AE	24c
7562N	24c	7615N	72c	4181AE	24c
7563N	24c	7616N	72c	4182AE	24c
7564N	24c	7617N	72c	4183AE	24c
7565N	24c	7618N	72c	4184AE	24c
7566N	24c	7619N	72c	4185AE	24c
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7569N	24c	7622N	72c	4188AE	24c
7570N	24c	7623N	72c	4189AE	24c
7571N	24c	7624N	72c	4190AE	24c
7572N	24c	7625N	72c	4191AE	24c
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7574N	24c	7627N	72c	4193AE	24c
7575N	24c	7628N	72c	4194AE	24c
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7579N	24c	7632N	72c	4198AE	24c
7580N	24c	7633N	72c	4199AE	24c
7581N	24c	7634N	72c	4200AE	24c
7582N	24c	7635N	72c	4201AE	24c
7583N	24c	7636N	72c	4202AE	24c
7584N	24c	7637N	72c	4203AE	24c
7585N	24c	7638N	72c	4204AE	24c
7586N	24c	7639N	72c	4205AE	24c
7587N	24c	7640N	72c	4206AE	24c
7588N	24c	7641N	72c	4207AE	24c
7589N	24c	7642N	72c	4208AE	24c
7590N	24c	7643N	72c	4209AE	24c
7591N	24c	7644N	72c	4210AE	24c
7592N	24c	7645N	72c	4211AE	24c
7593N	24c	7646N	72c	4212AE	24c
7594N	24c	7647N	72c	4213AE	24c
7595N	24c	7648N	72c	4214AE	24c
7596N	24c	7649N	72c	4215AE	24c
7597N	24c	7650N	72c	4216AE	24c
7598N	24c	7651N	72c	4217AE	24c
7599N	24c	7652N	72c	4218AE	24c
7600N	24c	7653N	72c	4219AE	24c
7601N	24c	7654N	72c	4220AE	24c
7602N	24c	7655N	72c	4221AE	24c
7603N	24c	7656N	72c	4222AE	24c
7604N	24c	7657N	72c	4223AE	24c
7605N	24c	7658N	72c	4224AE	24c
7606N	24c	7659N	72c	4225AE	24c
7607N	24c	7660N	72c	4226AE	24c
7608N	24c	7661N	72c	4227AE	24c
7609N	24c	7662N	72c	4228AE	24c
7610N	24c	7663N	72c	4229AE	24c
7611N	24c	7664N	72c	4230AE	24c
7612N	24c	7665N	72c	4231	

# ACE OF THE MONTH SPECIALS



## ASCII COMPUTER KEYBOARDS

These keyboards were manufactured for use on Texas Instrument's line of Silent 700 series data terminals. They are fully encoded with TTL large scale integrated circuits (T.I. TMS-5000 in 28 pin socket). Additional IC's provide a parallel 7 bit, without parity, code plus a strobe signal indicating "valid" data and six other independent outputs for those special keys which are not encoded. The keys are read type with a format similar to typewriter. Internal circuitry provides for two key rollover and de-bounce. Output is on standard 10 pin double readout connector for data and power input. And 8 pin double readout connector for six special switch functions.

## KEYBOARDS

- KB-6 - Clare/Pendar 720627-1  
T.I. Part number 959327-1  
A 56 key, ASCII encoded Alphanumeric keyboard with six extra switch closures to ground marked HERE IS, PAPER ADV., BREAK, REPEAT, TAPE, code 1 - \$47.50 2 - \$37.50 3 - \$17.50
- KB-7 - Clare/Pendar 720731-1  
T.I. Part number 959328-1 as used on T.I. Silent 700 data terminals. This is a 64 key full ASCII encoded keyboard, code 1 - \$49.95 2 - \$39.95 3 - \$19.95

1. All keyboards supplied with wiring diagrams, code tables, and other useful documentation.

- PRICE:
1. New - tested and guaranteed w/test record
  2. Used - tested and guaranteed w/test record
  3. Used - untested - appear to be in good condition.
- LSI Chip missing - may have a few bad or broken switches. Good for parts.



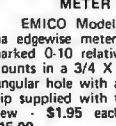
## ACOUSTIC COUPLER

This coupler was manufactured by Novation, Inc., Tarzana, California for use in Texas Instrument's model 725 Electronic Data Terminal. It is compatible with Bell 103 and 113 data sets or equivalent. The coupler operates asynchronously to a maximum speed of 450 baud in the full-or-half-duplex mode coupled to a standard telephone handset. Transmit freq. is 1270Hz for mark and 1070Hz for space. Receive frequency is 2225Hz for mark and 2025Hz for space. Unit required  $\pm 12$  VOLTS and  $\pm 5$  VOLTS for operation. Complete with schematic & all pertinent information, fully reconditioned, calibrated, and guaranteed - \$59.95.

## MEMORY CHIP



SN74S201N 256-BIT RAM with 3 state output. Plug in replacement for SN74-200 & SN74S200. \$35.95 ea. 10 for \$25.00 NEW GUARANTEED



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## IMSAI 8080 COMPUTER

(ALL BOARDS COMPLETELY "PLUG COMPATIBLE" WITH BASIC COMPUTER INCLUDES: CPU, FRONT PANEL CONTROL, BOARD, LIGHTS AND SWITCHES, POWER SUPPLY, EXPANDER BOARD AND CASE... PLUS 1K RAM... \$439 KIT... \$621 ASSEMBLED

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● (ITEM #21-1019) - Useful for same type applications as above unit, operates on 24-VDC. 3-1/8" x 1-5/8" x 1".

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● (ITEM #15-958) - Use for many spectacular experiments in electronics, physics, chemistry. 30,000 VAC output from 115-VAC. Fast, intense spark jumps 1/2" to 3/4". 6" x 4" x 3". (6 lbs.)



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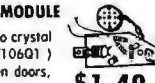
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2N336	.90	2N1377	.75	2N2323	1.00	2N3227	1.00	2N3866	.85	2N4442	.90
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2N443	1.75	2N1543	2.70	2N2327	3.80	2N3393	.17	2N3906	.25	2N5064	.50
2N456	1.10	2N1544	.80	2N2328	4.20	2N3394	.17	2N3925	3.75	2N5130	.20
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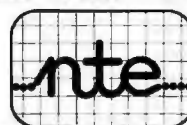
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<b>2N5460 P FET ..... \$4.5</b> <b>TIS 73 N FET ..... \$4.5</b> <b>2N4891 UJT ..... \$4.5</b> <b>ER900 TRIGGER DIODES ..... \$41.00</b> <b>2N6028 PROG. UJT ..... \$5.50</b>	<b>Low cost digital volt meter kit contains integ. circuit schem., PC boards, LED displays, regulators. Outer case and battery not supplied, accurate to one count, has range of one mv to 1.999 VDC. It features one V power supply - the oscillator is built into the chip. Overall dimensions 1 1/2" x 3" x 5" \$44.00</b>	<b>LINEAR CIRCUITS</b> LM 309K 5V 1A REGULATOR ..... \$1.35 723 - 40 - 40V REGULATOR ..... \$4 301/748 - Hi Per. Op. Amp. ..... \$1.05 307 OP AMP ..... \$1.05 CA 3047 - HI PERFORM OP AMP ..... \$5.5 CA 3089 FM IF SYSTEM ..... \$3.25 LM 320T 5, 12, 15 OR 24V ..... \$1.50 NEG. REGULATOR ..... \$1.50 741A or 741C OP. AMP. ..... \$1.05 709C OPER. AMP. ..... \$2.25 340T-5, 8, 12, 15, 18, 24V ..... \$1.75 POS. REG. TO-220 ..... \$1.75 101 OPER. AMP., HI PERFORM ..... \$1.75 LM 308 Oper. Amp., Low Power ..... \$1.05 747 - DUAL 741 ..... \$1.05 556 - DUAL TIMER ..... \$1.30 537 - PRECISION OP. AMP. ..... \$2.60 LM 3900 - QUAD OP. AMP. ..... \$4.9 LM 324 - QUAD 741 ..... \$1.50 560 - PHASE LOCK LOOP ..... \$2.00 561 - PHASE LOCK LOOP ..... \$2.00 565 - PHASE LOCK LOOP ..... \$2.00 566 FUNCTION GEN. ..... \$2.00 567 - TONE DECODER ..... \$2.00 703 - RF-IF AMP. ..... \$4.1 LM 370 - AGC SQUELCH AMP. ..... \$1.70 555 - 2 uS - 2 HR. TIMER ..... \$3.3 553 QUAD TIMER ..... \$3.50 FCD 810 OPTO-ISOLATOR ..... \$6.60 1458 DUAL OP. AMP. ..... \$5.85 LM 380 - 2W AUDIO AMP. ..... \$1.10 LM 377 - 2W STEREO AUDIO AMP. ..... \$2.50 LM 381 - STEREO PREAMP. ..... \$1.50 LM 382 - DUAL AUDIO PREAMP. ..... \$1.50 LM 311 - HI PER. COMPARATOR ..... \$5.95 LM 319 - Dual Hi Speed Comp. ..... \$1.10 LM 339 - QUAD COMPARATOR ..... \$1.25 8038C IC VOLT CONT. OSC. ..... \$3.90																																																																													
<b>VERIPAX PC BOARD</b> This board is a 1 1/2" single sided paper epoxy board, 4 1/2" x 6" DRILLED and ETCHED which will hold up to 21 single 14 pin IC's or 8, 16 or LSI DIP IC's with busses for power supply connector. <b>\$5.25</b>	<b>TTL IC SERIES</b> 74100— .26 74185— .35 7400— .14 7480— .48 7401— .15 7483— .75 7402— .15 7485— 1.05 7403— .15 7486— .34 7404— .18 7490— .49 7405— .18 7491— .79 7406— .35 7492— .49 7407— .33 7493— .49 7408— .18 7495— .74 7409— .18 7496— .79 7410— .15 74107— .34 7411— .25 74121— .38 7412— .30 74123— .74 7413— .45 74125— .54 7414— 1.45 74126— .54 7416— .33 74150— .92 7417— .33 74151— .69 7420— .15 74153— .79 7425— .27 74154— 1.05 7426— .24 74155— 1.05 7427— .27 74157— .75 7430— .15 74161— .95 7432— .24 74163— .95 7437— .29 74164— 1.10 7438— .29 74165— 1.10 7440— .15 74173— 1.35 7441— .95 74175— .95 7442— .59 74177— .75 7445— .79 74181— 2.30 7446— .87 74192— 1.10 7447— .87 74193— 1.10 7448— .95 74195— .74 7449— .28 74196— .95 7473— .34 8267— 1.95 7474— .35 75324— 1.75 7475— .45 75493— 1.0	<b>TRIACS</b> <table border="1"> <tr> <th>PRV</th> <th>1A</th> <th>10A</th> <th>25A</th> <th>1.5A</th> <th>6A</th> <th>35A</th> </tr> <tr> <td>100</td> <td>.40</td> <td>1.25</td> <td>.40</td> <td>.50</td> <td>1.20</td> <td></td> </tr> <tr> <td>200</td> <td>.70</td> <td>1.10</td> <td>1.25</td> <td>.60</td> <td>70</td> <td>1.60</td> </tr> <tr> <td>400</td> <td>1.10</td> <td>1.60</td> <td>2.60</td> <td>1.00</td> <td>1.20</td> <td>2.20</td> </tr> <tr> <td>600</td> <td>1.70</td> <td>2.30</td> <td>3.60</td> <td>1.50</td> <td>3.00</td> <td></td> </tr> </table>	PRV	1A	10A	25A	1.5A	6A	35A	100	.40	1.25	.40	.50	1.20		200	.70	1.10	1.25	.60	70	1.60	400	1.10	1.60	2.60	1.00	1.20	2.20	600	1.70	2.30	3.60	1.50	3.00																																											
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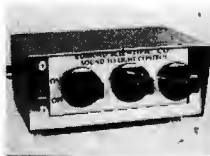
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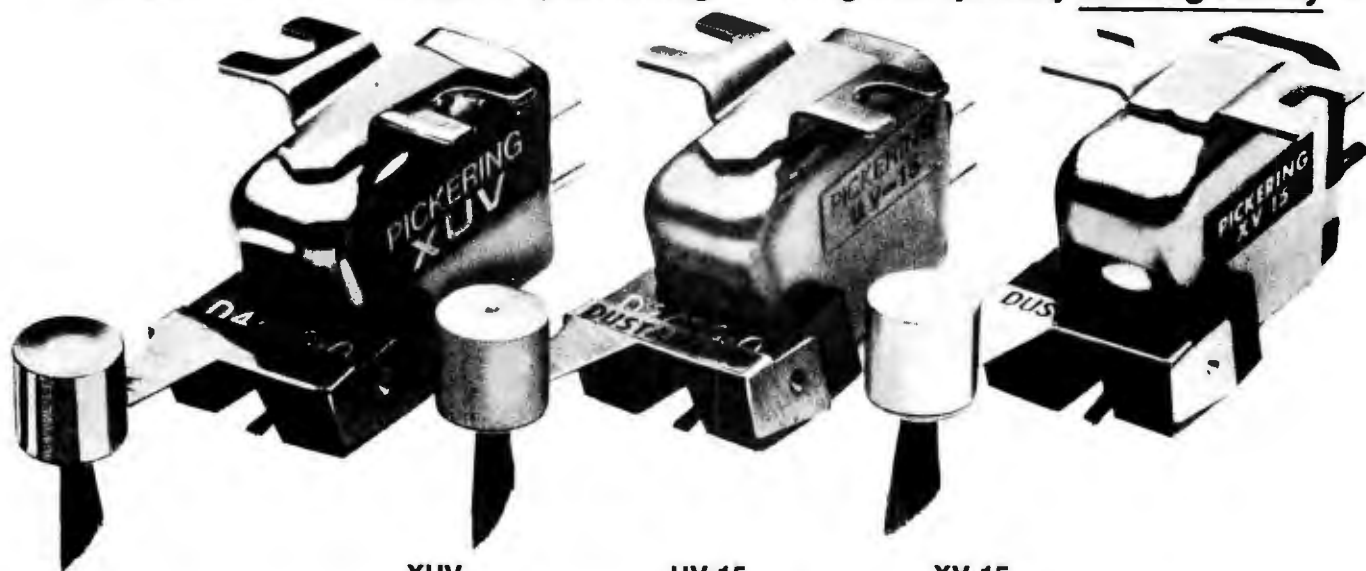
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# The right Pickering cartridge for your equipment is the best cartridge money can buy!







*They feature low frequency tracking and high frequency tracing ability\*!*



**XUV  
STEREO &  
DISCRETE**

**UV-15  
DISCRETE  
& STEREO**

**XV-15  
STEREO  
& MATRIX**

<b>Manual Transcription</b>	XUV/4500Q	UV-15/2400Q	XV-15/1200E UV-15/750E	
<b>Automatic Transcription</b>	XUV/4500Q	UV-15/2400Q	XV-15/1200E XV-15/750E	
<b>Manual</b>	XUV/4500Q	UV-15/2400Q	XV-15/400E XV-15/350	
<b>Automatic Turntable</b>		UV-15/2000Q	XV-15/400E XV-15/350	
<b>Manual/Automatic</b>		UV-15/2000Q	XV-15/200E XV-15/100	
<b>Changer</b>			XV-15/200E XV-15/150	

Pickering cartridges have been specifically designed and engineered not only to peak specific performance characteristics, but also to achieve total compatibility with your music system to help you get the most out of it.

Only Pickering has developed a way for you to be absolutely sure you select the "right" cartridge for your music system. We did it first for stereo by developing the Dynamic Coupling Factor rating system—DCF for short—which identifies pick-up performance in terms of quantitative measurement. The value of a DCF lies not only in its merit to define low frequency tracking ability but also in its high frequency (8 to 50 kHz)

**tracing ability.** Pickering's DCF-rated pick-ups have exceptional **high frequency tracing characteristics**, vital for both stereo and discrete 4-channel performance. The Pickering cartridge exactly "right" for maximum performance with your equipment is simple to select because of this rating method.

So, whether stereo or discrete (or both) is your preference, choose the Pickering cartridge exactly right for your equipment.

For further information write to Pickering & Co., Inc., Dept. PE, 101 Sunnyside Blvd., Plainview, N. Y. 11803

**\* traceAbility™**



"for those who can hear the difference"  
CIRCLE NO. 59 ON FREE INFORMATION CARD

# Would you recommend your turntable to your best friend?

## If not, you need a Dual.

If you were to replace any of your present components, would you know exactly what its successor would be? And then buy it without further consideration? Perhaps. But we think it more likely that you would look for more information, either in a music/equipment magazine or from a knowledgeable friend. Probably from both.

Which brings us to turntables... and Dual.

Each year we hear from a sampling of Dual owners in response to a lengthy questionnaire. A high percentage tell us they're now on their second Dual. An even higher percentage formerly owned manual turntables. And nearly all rate their Duals as either "excellent" or "good."

Although there are other fine turntables, few match Dual's reputation for quality performance and reliability, and none match Dual's operational versatility. For example, if you want to be able to play records in sequence, you have four single-play/multi-play Duals to choose from. If you simply want fully automatic convenience in a single-play-only turntable, you have two to choose from. And there is now a semi-automatic Dual.

The way a tonearm is moved to and from the record is not critical. Nor is the type of drive system. What is critical is how faithfully the tonearm permits the stylus to follow the contours of the groove and how accurately and quietly the platter rotates. To compromise with quality in these respects can risk damage to your precious records and produce sounds which were never recorded.

Every Dual, from the 1225 to the CS701, provides more precision than you may ever need. Which is why more component owners—audio experts, hifi editors, record reviewers and readers of the music/equipment magazines—own Duals than any other turntable.

There's no better recommendation we can offer you. Or that you can offer to your best friend. Unless you happen to own a Dual yours

**Dual 1225.** Fully automatic, single-play/multi-play. Viscous damped cue-control, pitch-control. 10 $\frac{1}{2}$ " platter, less base.

**Dual 1226,** with cast platter, rotating 3 $\frac{1}{2}$ " e-play spindle, \$169.95.

**Dual 1228,** with gimballed tonearm, new synchronous motor, illuminated strobe, variable tracking angle, \$199.95.

**Dual 1249.** Fully automatic, single-play/multi-play. Belt drive. 12" dynamically-balanced platter. \$279.95, less base. Full-size single-play models include: Dual 510, semi-automatic, \$199.95; Dual 601, fully automatic, \$249.95. (Dual CS601, with base and cover, \$270.)

**Dual CS701.** Fully automatic, single-play. D.C. brushless, electronic direct drive motor; tuned anti-resonance filters. \$400, including base and cover.



Dual 1225



Dual 1249



Dual CS701

**United Audio Products, 120 So. Columbus Ave., Mt. Vernon, N.Y. 10553**  
CIRCLE NO. 4 ON FREE INFORMATION CARD

(Exclusive U.S. Distribution Agency for Dual)

**Dual**<sup>®</sup>